VOLUME 40 NUMBER 3 SEPTEMBER, 1955

AMERICAN JOURNAL OF OPHTHALMOLOGY

THIRD SERIES FOUNDED BY EDWARD JACKSON

CONTENTS

DEPARTMENTS

For complete table of contents see advertising page xxxi

Publication office: 450 Ahnaip St., Menasha, Wisconsin

Subscription price in United States twelve dollars yearly. In Canada and foreign countries fourteen dollars. Published monthly by the Ophthalmic Publishing Company. Subscription and Advertising Office: 664 North Michigan Avenue, Chicago 11, Illinois. Entered as second class matter at the post office at Menasha, Wisconsin. Printed in U.S.A.

New Clini Camera C–

easy to use as a BROWNIE

only $150.00

See the new Clini Camera C at the American Academy of Ophthalmology. Learn how amazingly efficient and easy it is to operate—how you can always get brilliant, color correct external eye photos.

Jenkel-Davidson
OPTICAL COMPANY

American Academy of Ophthalmology and Otolaryngology
Booth 108, Exhibition Hall, Palmer House, Chicago

366 POST STREET • SAN FRANCISCO, CALIFORNIA

in eye disorders[5]

"...free of significant metabolic, water or electrolyte disturbances."[1]

The higher therapeutic ratio of METICORTEN permits marked clinical benefits unaccompanied by many of the major undesirable actions characteristic of cortisone and hydrocortisone.[1-4]

METICORTEN

PREDNISONE (metacortandracin)

Schering

- avoids sodium and water retention
- avoids weight gain due to edema
- no excessive potassium depletion
- better relief of pain, swelling, tenderness; diminishes joint stiffness
- lowers sedimentation rate even where cortisone or hydrocortisone ceases to be effective—"cortisone escape"
- most effective in smallest dosage

Bibliography

(1) Dordick, J. R., and Gluck, E. J.: J.A.M.A. *158*:166, 1955. (2) Bunim, J. J.; Pechet, M. M., and Bollet, A. J.: J.A.M.A. *157*:311, 1955. (3) Barach, A. L.; Bickerman, H. A., and Beck, G. J.: Dis. Chest *27*:515, 1955. (4) Schwartz, E.: J. Allergy *26*:206, 1955. (5) King, J. H., Jr., and Weimer, J. R.: A.M.A. Arch. Ophth. *54*:46, 1955.

SCHERING

METICORTEN,* brand of prednisone (metacortandracin).
*T.M.

As changeable  as

NEW UNIVIS Command Performance™ Frames feature TRIM-LOK™*

interchangeable jewel trims to multiply interest in eye wear as a fashion accessory.

* Patent Pending

Lifts Off! Clicks On!

And *stays* on 'til the mood changes!

So simple a patient can do it! Just lift off, select jewel trim . . .

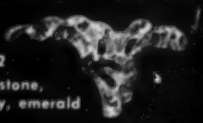
. . . then *click* both metal pins into the patented TRIM-LOK™ *recesses* in end piece.

These beautiful Command Performance™ frames . . . . . with these delicate . . . . . .

ARDOUR TR-1 (trim) (standard on frame)
Colors: Ivory, blue, maroon, black

BEGUINE TR-1 (trim) (standard on frame)
Colors: Ivory, blue, maroon, black

ENSEMBLER TR-1 (trim) (standard on frame)
Colors: Ivory, blue, maroon, black



ARDOUR TR-2
Colors: Rhinestone, sapphire, ruby, emerald

BEGUINE TR-2
Colors: Rhinestone, sapphire, ruby, emerald

ENSEMBLER TR-2
Colors: Rhinestone, sapphire, ruby, emerald

Ardour™ EYE SIZE: 42 and 44. BRIDGE SIZE: 20 and 22.

milady's moods!

TRIM-LOK... adds a new cosmetic dimension!

Women and fashion experts cheer the color touch in eyeglass frames to highlight style, point up costume and accessory colors. But here's the big news: Trim Lok interchangeable jewel trim, designed specifically to create multiple-pair purchases by adding a new dimension to the cosmetic appeal of eyeglasses to American women.

With Trim Lok, women can *alter* a basic pair of glasses to fit the *style* of outfit *and* to pick up hues of costumes and accessories.

Stimulates multiple pair sales.

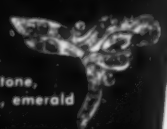
Far from discouraging such sales, Trim Lok encourages the desire to build frame wardrobes by opening an entirely new avenue of interest in eye wear.

And presto! Milady has frames to flatter accessories, other jewelry and entire costume.

Smartly Styled Command Performance Presentation Kit.

(Available through your Univis laboratory.)

....trims.....



ARDOUR TR-3
Colors: Rhinestone, sapphire, ruby, emerald

BEGUINE TR-3
Colors: Rhinestone, sapphire, ruby, emerald

ENSEMBLER TR-3
Colors: Rhinestone, sapphire, ruby, emerald

...match any costume color in seconds!

Ensembler TM

EYE SIZE: 42, 44, 46. BRIDGE SIZE: 18, 20, 22
TEMPLES: LB-4", LO-5¼"; LB-4¼", LO-5½"; LB-4½", LO-5¾".
FRAME COLORS: Clear bridge: black, mocha, slate blue. Solid: black, mink, slate blue. Wine overlaid on crystal.

UNIVIS TM

All are products of

THE UNIVIS LENS COMPANY / Dayton, Ohio

Manufacturers of Univis precision straight-top multifocal lenses

infection
inflammation
injury
allergy

SODIUM SULAMYD® solution 30%-10%—ointment 10%

CORTOMYD®—Cortisone and Sodium Sulfacetamide suspension

CORTOGEN®—Cortisone Acetate—0.5%-2.5% suspensions

CORTICLORON®—Cortisone and Chlor-Trimeton® suspension

ASSURED STERILITY

relieves
even "difficult"
ophthalmic
allergies

CORTICLORON® *Ophthalmic Suspension 15 cc. contains:*

0.5% Cortisone acetate and
0.25% CHLOR-TRIMETON® maleate

also

15 cc. CORTICLORON Nasal Spray in plastic bottle.

TREAT MORE AILMENTS OF THE EYE

with RAYTHEON MICROTHERM®

An advantage of microwave therapy is that it is possible to heat the deeper tissues without undue heating of the more superficial tissues.[1]

Microwave diathermy offers a simple and rational method of treating diseases of the posterior ocular segment if maintenance of visual acuity (20/40) is used as a criterion of success.[1]

Raytheon Microtherm has been employed with generally encouraging results in secondary senile macular degeneration, retrobulbar neuritis, central serous retinopathy, certain thrombotic and hemorrhagic conditions, and post-operative uveitis.[1]

Ask your medical supply dealer for a demonstration of new Raytheon Microtherm, Model CMD-10.

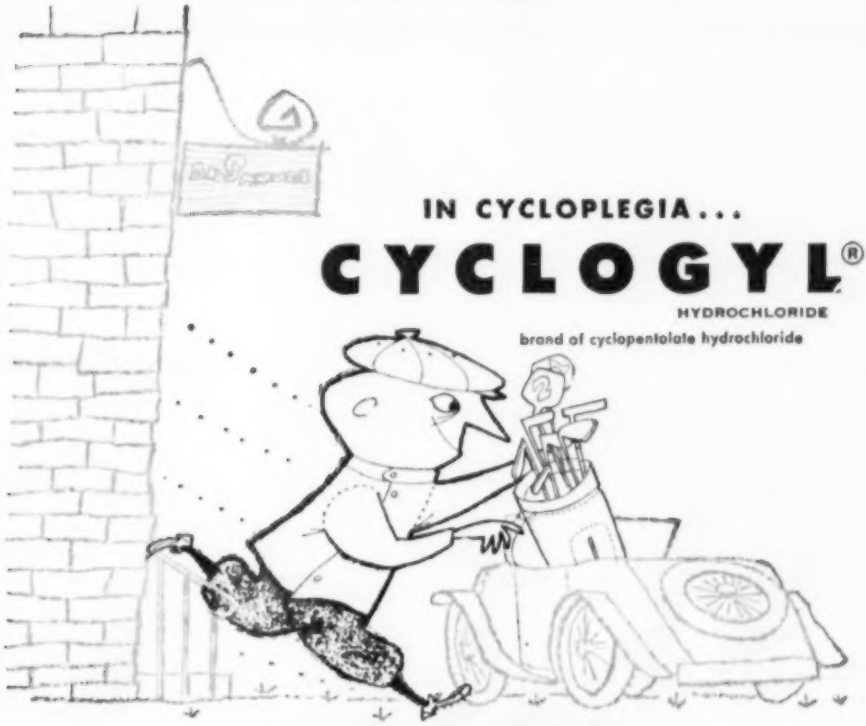
Excellence in Electronics

RAYTHEON

1. Clark, W. B., Transactions of A.A.O. and O. 7-8, 1952. Copies of this paper are available on request.

RAYTHEON MANUFACTURING COMPANY

Microwave and Power Tube Operations, Section NR-EB, Waltham 54, Massachusetts



IN CYCLOPLEGIA . . .

CYCLOGYL®

HYDROCHLORIDE

brand of cyclopentolate hydrochloride

SAVES TIME

. . . for you . . . with rapid onset of action

. . . for your patients . . . with rapid recovery

"Cyclopentolate hydrochloride . . . produces a rapid [30 to 60 minutes], intense cycloplegia and mydriasis of moderate duration . . . and is effective in highly pigmented irises and for persons of all ages."

New and Nonofficial Remedies, Philadelphia, J. B. Lippincott Company, 1954, p. 189.

Cyclogyl has shown outstanding qualities in 1035 cases.[1]
(Incorporates work of 11 previous investigators)

Compound	Dosage and Administration (drops) *	Diopters of Residual Accommodation	Spontaneous Recovery (in hours)
Cyclogyl 0.5%	2	1.10	24†
Homatropine 2% or 4%	2	2.00	48

*Successive drops at five-minute intervals.

†Recovery time reduced to six hours after one-percent pilocarpine.

1. Gordon, D. M., and Ehrenberg, M. H.: Am. J. Ophth. 38:831 (Dec.) 1954.

"the chief handicap of maximum cycloplegia, namely its incapacitating effect, is minimized . . ."

Gasset, B. C.: A.M.A. Arch. Ophth. 51:467 (Apr.) 1954.

Cyclogyl, "by virtue of its brevity, rapidity of action, and consistent depth of cycloplegia, will be [a drug of choice] for routine refraction . . ."

Ehrlich, L. H.: New York J. Med. 55:3015 (Dec. 15) 1955.

Dosage:

Cycloplegia — One drop 1.0%, in each eye (or two drops of 0.5%) produces maximal cycloplegia in 30-60 minutes. Recovery time is normally 4-12 hours spontaneously. Pilocarpine reduces recovery time. In deeply pigmented eyes, 2 drops of 1.0% in each eye, instilled 10 minutes apart, achieves satisfactory cycloplegia in 98% of cases.

Mydriasis — One or two drops of 0.5% in each eye.

Samples and Literature on request.

Supplied:

Sterile ophthalmic solution in Gifford's Buffer (pH 6.0)
0.5% Solution — 15 cc Dropper Bottles
1.0% Solution — 15 cc Dropper Bottles
2 cc Dropper Bottles

Schieffelin & Co. Since 1794

Pharmaceutical and Research Laboratories
New York 3, N. Y.

The Sixth Annual Meeting of the New Orleans Academy of Ophthalmology will be held in New Orleans, Roosevelt Hotel, January 3-6, featuring "Diseases and Surgery of the Lens". The registration fee of $75.00 includes membership in the Academy for the year 1956. Hotel reservations should be made early by writing to the Roosevelt or 211 S. Saratoga St., New Orleans, La.

AMERICAN JOURNAL OF OPHTHALMOLOGY

SERIES 3 · VOLUME 40 · NUMBER 3 · SEPTEMBER, 1955

CONTENTS

AMERICAN JOURNAL OF OPHTHALMOLOGY

VOLUME 40 SEPTEMBER, 1955 NUMBER 3

PERSISTENT HYPERPLASTIC PRIMARY VITREOUS*

THE JACKSON MEMORIAL LECTURE

ALGERNON B. REESE, M.D.
New York

The Jackson Lecture, by virtue of its symbolic commemoration and the high standard set by the previous lectures has come justly to its present high estate. I am particularly eager that this lecture should be found worthy of the occasion because it was at this meeting just 50 years ago that Dr. Edward Jackson presided as the first president of this society under its present name. Dr. Jackson was elected a member of the Western Ophthalmic and Oto-Laryngologic Association in 1902 and took a very active part in the scientific program. In 1903, Dr. Casey Wood's report, as chairman of a committee to draw up a new constitution and by-laws, was adopted. This included changing the name of the organization to "The American Academy of Ophthalmology and Otolaryngology." At the first meeting in Denver, Colorado, August, 1904, Dr. Jackson was president. Dr. Derrick T. Vail of Cincinnati was secretary. The presidential address was "Education for ophthalmic practice." On this occasion, as well as on others, Dr. Jackson championed the appraisal by a suitable board of one's fitness to practice ophthalmology, thus presaging the American Board of Ophthalmology. He also decried the tendency to overspecialization. In this regard it may be that I am an offender today.

We have employed the term leukokoria (white pupil) for the group of conditions in infants and children frequently referred to as pseudoretinoblastoma. My interests have been in several conditions belonging to this group, and even at the risk of being branded a leukokorologist, the epitome of overspecialization, I wish to discuss still another one of the group—persistent hyperplastic primary vitreous.

Persistent hyperplastic primary vitreous and persistent hyperplastic vitreous are the terms used to designate the condition often called "persistent tunica vasculosa lentis" or "persistent posterior fetal fibrovascular sheath of the lens."

The tunica vasculosa lentis is actually a very meager layer of small vascular channels surrounding the lens and stemming from three sources: from the hyaloid artery, from the vasa hyaloidea propria (these are derived from the vessels which pass into the peripheral parts of the vitreous and enter the vascular tunic of the lens at its equator), and, lastly, from the anterior ciliary vessels which stem from the major arterial circle of the iris.

The anterior part of this vascular tunic of the lens is supplied by the ciliary system, while the posterior portion is fed by the hyaloid system. The former (anterior part) normally shows a complete regression at about the eighth month of fetal life, although it is not at all unusual, particularly in premature infants, to see some evidence of this system at birth. The latter (posterior part) usually shows complete regression at about

* From the Institute of Ophthalmology of the Presbyterian Hospital, New York. This work has been supported by a grant from the Dunlevy Milbank Foundation, Inc. Presented at the 59th annual session of the American Academy of Ophthalmology and Otolaryngology, September 19-24, 1954, New York, New York.

the seventh fetal month, but remains of this system are also commonly seen at birth, particularly in premature infants. If hyperplasia does not occur, both systems may achieve continued and complete regression after birth.

Clinically speaking, the two portions seem to have little or no relationship; persistence and hyperplasia of the one occur independently of the other. There are two aspects of the posterior system—the fibrovascular sheath and the hyaloid artery (figs. 1, 2, 3, and 4). When remains of the sheath are present, we commonly see remains, too, of the hyaloid artery or of some feature of the hyaloid system. Also, when the hyaloid artery dominates the picture we sometimes see some degree of the remains of the posterior fibrovascular sheath of the lens. This association of the two portions is not surprising since both are remains of elements of the primary vitreous. One or the other, however, usually predominates.

When retrolental fibroplasia became a major problem about 1942[37-40] it was thought to be related to persistent hyperplastic vitreous. Further experience proved, though, that the two conditions are separate entities.[38]

Material

Because of an interest in both retinoblastoma and retrolental fibroplasia, I have had the opportunity to see a relatively large number of allied conditions. Therefore, my series of clinical cases of persistent hyperplastic vitreous in various stages number 59, and in many instances I have been able to follow the lesion from its detection to the ultimate fate of the eye. I am prompted to report my experience with these cases because I have been struck (1) by the wide clinical variations which they manifest and (2) by the fact that this bizarre clinical picture is frequently not appreciated. Furthermore, the eyes harboring these lesions usually are ill-fated. As a matter of fact, I have not been able to discover a single recognizable case in an adult. It is true that mild lesions of this type may run an uncomplicated course and be seen occasionally in adult eyes. It has been challenging to undertake measures to prevent the complications which lead ultimately to the loss of such eyes. It is possible that I have been successful in some degree in this aspect of my endeavor.

As eyes with persistent hyperplastic vitreous often are either removed with a diagnosis of retinoblastoma or develop complications which lead to enucleation, the pathologic material for study is rather rich. It has been interesting, therefore, to try to correlate the clinical observations with the pathologic material. I have had the opportunity to study microscopic sections of 47 eyes* with persistent hyperplastic vitreous of varying degrees of severity at various stages in the course of the disease. Twenty-two eyes were available from the pathology collection of the Institute of Ophthalmology and 25 eyes have been studied through the courtesy of the Armed Forces Institute of Pathology.

* Also, I have a dog's eye with typical persistent hyperplastic vitreous. The globe was enucleated because retinoblastoma was suspected.

→

Figs. 1, 2, 3, and 4 (Reese). (Fig. 1). A section of the normal eye of a four-months fetus showing the loose vascularized fibrous tissue (*a*) composing the primary vitreous. The hyaloid artery is seen at (*b*). (Taken from Bach and Seefelder, *Atlas zur Entwicklungsgeschichte des menschlichen Auges*, 1911.) (Fig. 2). A normal, seven-months fetal eye with the sclera resected so that the primary vitreous can be seen as a cone-shaped tissue with the base back of the lens and the apex at the disc. (Lent through the courtesy of Dr. H. C. Haden.) (Fig. 3). A normal seven-months fetal eye, showing the character of the primary vitreous back of the lens. (Lent through the courtesy of Dr. H. C. Haden.) (Fig. 4). An eye with persistent hyperplastic vitreous. The sclera has been resected to show the similarity to the primary vitreous in fetal eyes. (*a*). Fibrovascular tissue back of lens; (*b* and *b'*) hyaloid artery; (*c*) long ciliary processes; (*d*) swollen lens and iris against cornea. Section of this eye shown in Figure 7.

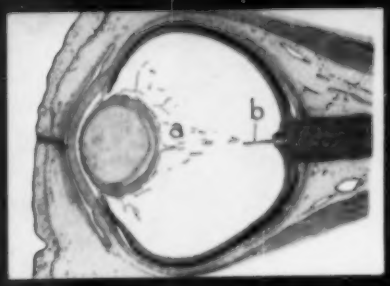


Figure 1

Figure 2

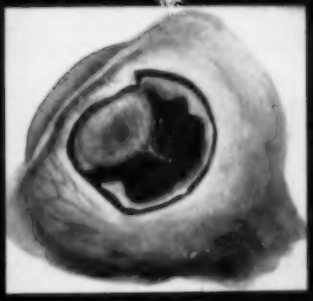


Figure 3

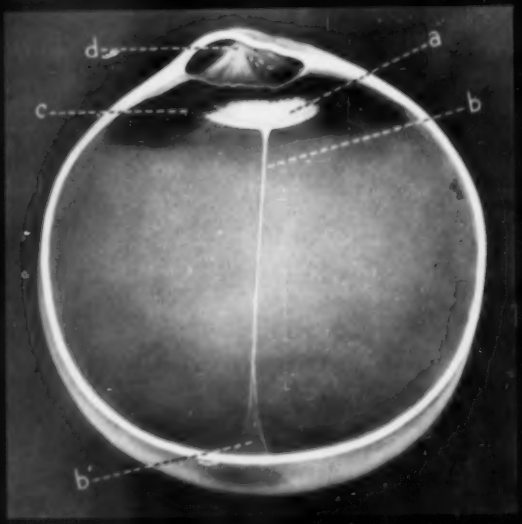


Figure 4

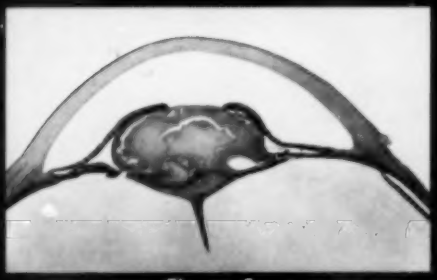


Figure 5

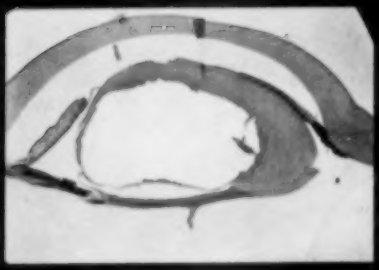


Figure 6

Figure 7

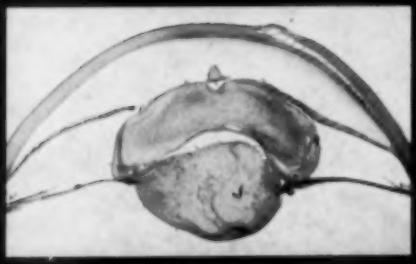


Figure 8

Pathology

The fibrous tissue back of the lens varies a great deal in extent and thickness (figs. 4, 5, 6, 7, and 8). It may not only cover the entire posterior surface of the lens but may even extend from one ciliary region to the other; or it may occupy only a portion of the lens surface on the nasal side (fig. 6). The thickness may vary from that of a thin membrane to a thickness as great as, or greater than, that of the lens itself. The central portion is usually thicker than the peripheral.

There are various degrees of vascularization, and sometimes in this tissue there is evidence of recent or old hemorrhage and blood pigment. There are some (Heine,[13] Hamma,[12] Lane[20]) who believe that hemorrhage plays an important role in producing the fibrovascular sheath.

Fat, smooth muscle, calcium deposits, cartilage, eosin-staining hyaloid material, and islands of undifferentiated neuroepithelium may be present. The fibrous tissue seems to be composed of connective tissue (van Gieson and Mallory stains) although it is possible that there are sometimes glial components (von Hippel[16]). The lens zonules may be inserted into the periphery of the fibrovascular sheath (Collins,[2] von Hippel[16]). The pathway of the venous return from the fibrovascular sheath is highly speculative (von Hippel[16]).

Very rarely, fibrous filaments extent from the posterior surface of the retrolental tissue toward the retina and may even pull the retina away from the choroid. These extensions are evidently remains of the vasa hyaloidea propria. It is extremely uncommon for the retina to be detached and lie in folds around the fibrovascular sheath; this occurrence seems to be due to spontaneous hemorrhage and organization (fig. 25).

The hyaloid artery can usually be seen where it enters the posterior surface of the tissue in the central part on the nasal side. This artery may be patent or atresic. It usually has around it an easily detectible layer of smooth muscle which extends into and along the fibrovascular sheath.

The lens is small and sometimes shows a posterior concavity (Pollock[27]), giving it a kidney shape. One of the most striking findings is a central opening in the posterior capsule (Parsons,[26] Collins,[2] Pollock,[27] Leech,[21] Seefelder,[33] Sanders,[32] von Hippel,[16] Marshall[23]). This break in the capsule can be seen in almost every eye harboring persistent hyperplastic vitreous (figs. 5, 7). Pollock[27] felt that the capsular rent occurs about three months after birth. Collins[1] believed that it occurs early in fetal life and may be the cause of the persistent and hyperplastic fibrovascular sheath and hyaloid artery.

My impression is that it usually occurs after birth, but this opinion is based on clinical observations of cases in which the lens is at first clear but later develops cataractous changes. The lens epithelium, the fibrous tissue, and the blood vessels tend to proliferate into the lens through the opening

Figs. 5, 6, 7, and 8 (Reese). (Fig. 5). A section of a globe with persistent hyperplastic vitreous. The hyaloid artery is seen posterior to the retrolental tissue. There is a rupture of the capsule of the lens at the posterior pole. The long ciliary processes extend up to the fibrous tissue. (Fig. 6). A section of an eye with persistent hyperplastic vitreous. The fibrous tissue with the hyaloid artery is shown to the nasal side of the lens and into this the long ciliary processes extend. (AFIP no. 185, 415.) (Fig. 7). A section of an eye with persistent hyperplastic vitreous. There is a break in the posterior capsule of the lens with adjacent cataractous changes. The lens is swollen and protrudes, cone-shaped, through the pupillary area. It touched the cornea in vivo but has retracted during preparation of the sections. Same eye as shown in Figure 4. (Fig. 8). A section of an eye with persistent vitreous. Back of the kidney-shaped lens is an extremely thick mass of fibrous tissue in which are several areas of cartilage. Some retinal elements and ciliary processes extend up to the fibrous tissue.

in the posterior capsule. Hemorrhage sometimes occurs inside the lens (Parsons,[25] Collins,[3] Lane[20]). There usually is a wrinkling of the posterior capsule. This wrinkling is apparently due to contracture of the fibrous tissue along its posterior surface. It may be, therefore, that the contracting fibrous tissue is responsible for the opening which occurs in the capsule. Another frequently observed feature is the extension of the lens epithelium under the capsule posteriorly (Gifford and Latta,[9] Pollock,[27] Sanders,[32] Dötsch,[6] Ginsberg[10]). Not only is the lens smaller in diameter and thinner than normal, but also there is a gradual absorption of the lens substance due to the opening in the posterior capsule. Ultimately the lens may be totally absorbed (figs. 17, 26) (Findlay,[8] von Grolman,[11] Czermak[5]) with only the capsule remaining in a bed of fibrous tissue, or the lens may shrink to a small globule of old calcified cortex surrounded by the capsule.

Elongated ciliary processes are a constant finding. They usually extend as far as the equator of the lens and they are frequently incorporated in the periphery of the fibrovascular tissue. They are hyperemic and their stroma is sometimes replaced by dilated vascular channels. Ida Mann, in discussing Hudson's paper,[19] felt that long, drawn-out ciliary processes are often seen in maldeveloped eyes, particularly in conjunction with congenitally malformed lenses. She thought they are due to adhesion of the processes to the vascular sheath (normal to about the fifth month). If this adhesion persists, the processes are drawn out in the subsequent growth of the eye.

There may be evidence of chronic inflammation in these eyes (Findlay,[8] Leech,[21] Pollock[27]), but it is noted early in the eyes in which lens absorption is taking place. Leech (and also Pollock) felt that such inflammation indicated that a fetal iritis had caused the persistent hyperplastic vitreous. I feel sure, however, that this inflammatory reaction occurs in response to the presence of the lens matter.

Characteristically, the retina in these eyes is in place and contains all of its nuclear and fibrous elements as well as a well-formed fovea. There is no reason, therefore, to believe, judging from the appearance of the retina, that it would not be capable of good function. A common feature is an extension of the retina peripherally toward the flat portion of the ciliary body and even to the ciliary processes. Sometimes the retina extends, or is pulled, into the periphery of the fibrous tissue back of the lens, usually without promoting an actual detachment of the retina.

The filtration angle usually shows some degree of malformation (Terry,[43] Paganelli[24]). This is in the nature of an embryonic type of angle wherein the iris processes form a bridge between the cornea and iris. Sometimes the trabecular spaces and

→

Figs. 9, 10, 11, and 12 (Reese). (Fig. 9). The clinical appearance of an eye with persistent hyperplastic vitreous. The densest part of the lesion is noted in the center. When the periphery of the tissue is viewed (right) the long ciliary processes are seen. This eye was successfully operated on and the final result is shown in Figure 29-B. (Fig. 10). An eye with persistent hyperplastic vitreous which partially covers the posterior nasal surface of the lens. The densest portion is at the posterior pole. Beyond the equator of the lens nasally the long ciliary processes are seen. This eye was enucleated two and a half years later with buphthalmos and an opaque cornea. Sections of the eye show persistent hyperplastic vitreous with the hyaloid artery. (Fig. 11). An eye with persistent hyperplastic vitreous. The lens is becoming cataractous at the posterior pole. The swollen lens causes an extremely narrow anterior chamber. The insert shows the ciliary processes in the periphery nasally. (Fig. 12). An eye with persistent hyperplastic vitreous. In this eye the lens is more cataractous than in the case shown in Figure 11. The swollen lens almost touches the cornea. When the pupil was miotic the iris was pushed forward, pyramidal shaped, but when dilated, as shown in the illustration, the equator of the swollen lens extended beyond the pupillary margin. The long ciliary processes can be seen indistinctly through the partially opaque lens. The iris shows many dilated blood vessels. This eye was successfully operated on and now has a round black pupil.

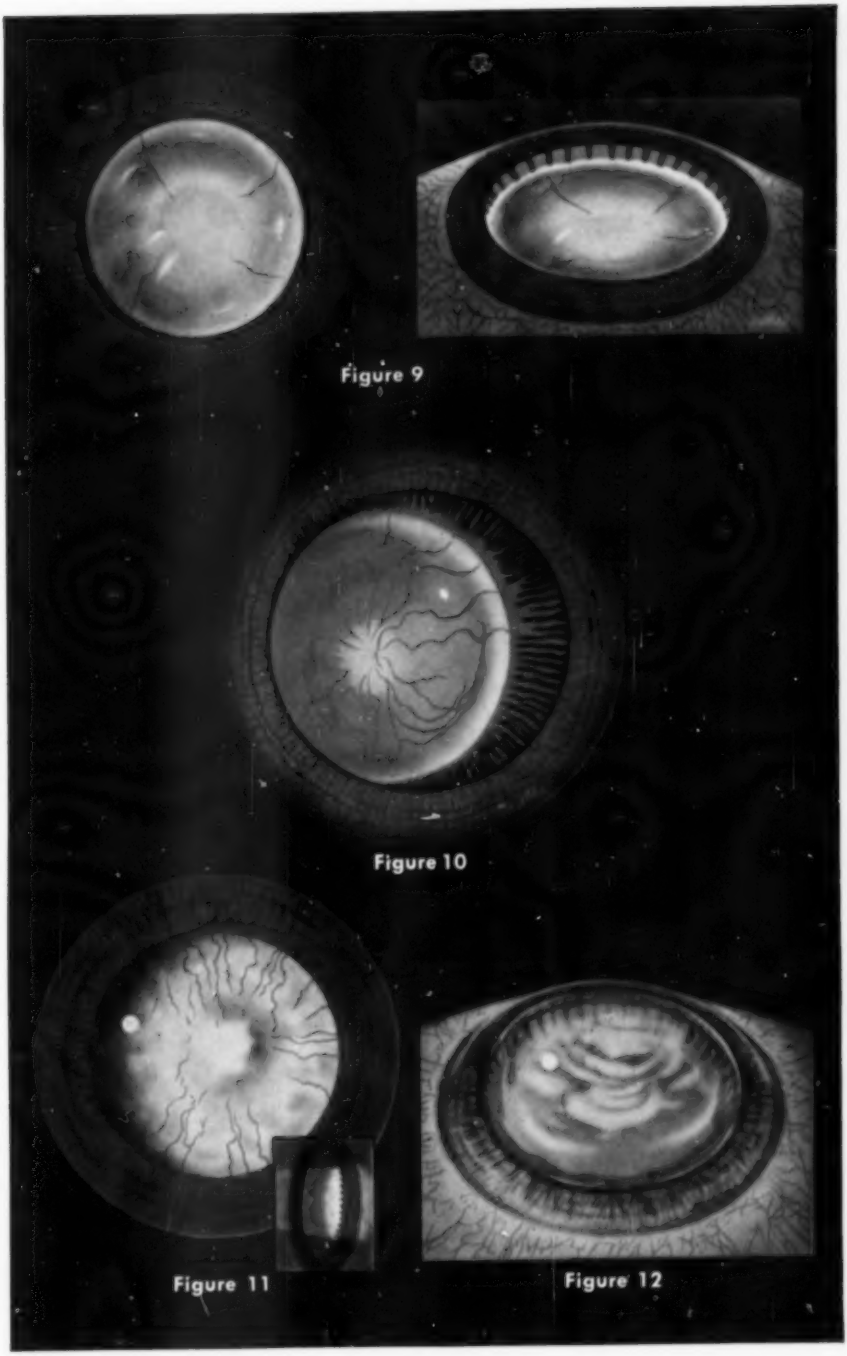


Figure 9

Figure 10

Figure 11

Figure 12

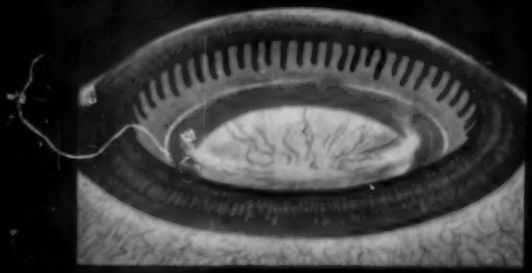


Figure 13 A

Figure 13 B

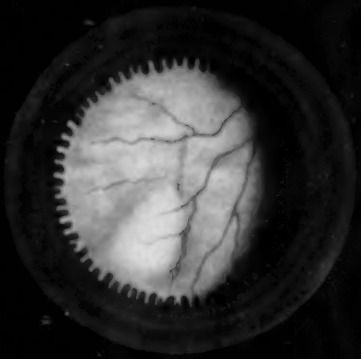


Figure 15

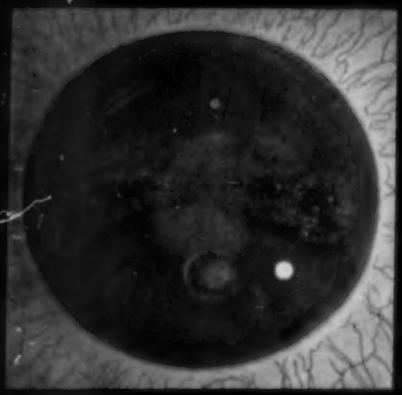


Figure 14

Schlemm's canal do not appear patent.

Hemorrhage may be a feature in the more advanced cases and is seen not only in the lens and in the tissue back of the lens but also, in various stages of organization, in the vitreous. This may cause the retina to be detached and drawn up into the organizing and contracting tissue (fig. 25).

Clinical observations and a study of available pathologic material indicate that eyes with persistent hyperplastic vitreous are lost in two ways. One way is through swelling of the lens due to an opening in the posterior capsule, and the other is from spontaneous hemorrhage. These two factors will be amplified later.

Clinical course

In clinical appearance this lesion assumes the most protean forms. This is due in part to varying severity, but it is also due to the facts (1) that the process is never static but always changing and (2) that the natural course leads to sequelae and complications. The lesion occurs in full-term infants of normal birthweight with no unusual features during the prenatal and postnatal course.

The presence of the lesion is usually noted by the physician or the parents immediately after birth or within a few weeks thereafter. In 90 percent of the cases the lesion is unilateral with a perfectly normal fellow eye, or merely a Mittendorf dot or some such slight manifestation in the fellow eye. The affected eye has a shallow anterior chamber and is almost invariably smaller than its fellow. (I have seen two exceptions to this.) The degree of microphthalmos may be so slight, however, that it is not appreciated unless looked for or unless the cornea is actually measured. Some of the patients have nystagmus (Marshall,[23] Gifford and Latta[9]) and the affected eye may show an esotropia or, rarely, an exotropia.

The tissue back of the lens (figs. 9, 10, 20), usually densest in the center and thinning toward the periphery, has a pinkish white color and varies in size from just a small plaque (located nasally to the center of the lens) to an area completely covering the posterior surface of the lens. There is always some vascularity of this tissue, and vessels frequently radiate from the center. When the pupil is dilated, the ciliary processes can be seen extending toward, into, or anterior to, the periphery of the opaque tissue. These long ciliary processes are a characteristic feature of the disease and often serve as a differentiating point in the diagnosis. The fibrous tissue undergoes gradual contracture, which draws the process centrally and makes them clearly visible (figs. 16 and 20). Hemorrhage which is sometimes seen in or around the tissue (figs. 13, 18, 20), seems to appear several months (most often around four months) after birth.

The lens characteristically is smaller in diameter (Findlay,[8] Hudson[19]) than would be normally expected even in a somewhat microphthalmic globe. For this reason, the equator of the lens can frequently be seen easily, and occasionally it is inside of, and concentric to, the pupillary margin when the pupil is dilated (figs. 10, 12, and 20). Sometimes the lens border protrudes through the dilated pupil, particularly on the nasal side (fig. 12). In such instances the iris, when the

←

Figs. 13A, 13B, 14, and 15 (Reese). (Fig. 13A). An eye with persistent hyperplastic vitreous showing hemorrhage around the periphery of the tissue. (Fig. 13B). The same eye four months later. Anterior synechias with corneal opacification are seen at one site; the ciliary processes have been drawn further centrally and there is an ectropion of the iris. (Fig. 14). This eye had a typical persistent hyperplastic vitreous in its uncomplicated state. The eye is shown here seven years later with anterior synechias, central corneal opacification, almost total obliteration of the anterior chamber, and a band keratopathy. (Fig. 15). This eye has a persistent hyperplastic vitreous with spontaneous absorption of the lens. The yellowish island of tissue is the only lenticular remains seen. The ciliary processes are noted around the periphery. There is no glaucoma. The eye was successfully operated on.

pupil is not dilated, protrudes cone-shaped.

The lens is at first clear and later becomes cataractous (figs. 9, 10, 11, and 12). These cataractous changes make their primary appearance at the posterior pole (fig. 11) where the opacity mushrooms forward into the still transparent portion of the lens. This opacity gradually increases until the entire lens is opaque. The development of the cataractous change is accompanied by a swelling of the lens, which frequently comes forward, together with the iris, and touches the cornea (figs. 4, 7, 12, 21, 22, 23, and 24). This development is accompanied by secondary corneal changes in the form of edema and, later, of scarring (figs. 13, 14 and 18). Such complications are usually followed by glaucoma. If, on the other hand, the swelling of the lens is not sufficient to cause its apposition to the corneal surface and to provoke secondary glaucoma, the lens may undergo absorption and leave only the capsular remains over the surface of the retrolental tissue (figs. 15, 16, 17, and 26). Or, the lens may undergo partial absorption and be seen as a contracted globular mass, usually calcified, lying in the central part of the concave tissue (figs. 18 and 19). Occasionally a posterior lenticonus can be appreciated before the lens becomes opaque (Steffen,[20] Seefelder,[25] Cordes,[4] Collins[1]). Hemorrhage may be seen rarely inside the lens (from the fibrovascular sheath which proliferates into the lens substance through the opening in the posterior capsule) associated with or without siderin and crystals. These by-products of hemorrhage may be seen to emerge into the anterior chamber when the lens capsule is opened at the time of a needling operation. The crystals may be seen over the iris and in the pupillary area for a long time thereafter.

The iris usually shows abnormally large and numerous blood vessels, most of which course radially (Hudson,[19] Leech[21]). Sometimes it shows one or more large anomalous vessels which may extend onto the surface of the lens or around the pupil to be lost in the posterior chamber, or they may be seen to anastomose with the blood vessels in the retrolental tissue. Ida Mann, in discussing Hudson's paper,[19] stated that the iris vascularity in these cases resembled that seen in the fetus from the seventh to the eighth month, when all vessels are visible. The pupil often dilates rather poorly with mydriatics (Lent and Lyon[22]). In the more advanced cases there may be ectropion and atrophy of the iris. Remains of the fetal pupillary membrane have not been noted as a feature of the disease.

Glaucoma is a common complication and, as stated, it seems to be caused usually by the swelling of the lens. It is doubtful that the cause is malformation of the filtration angle because glaucoma is not encountered in the early stages, but only late in the course when the anterior chamber becomes more shallow or is even obliterated by a swelling of the lens. A second cause of the glaucoma may be spontaneous hemorrhage in the vitreous or in the perilenticular area.

Figs. 16, 17A, 17B, and 19 (Reese). (Fig. 16). An eye with persistent hyperplastic vitreous. The lens has been completely absorbed. The only lenticular remains seen is the white island of tissue above. The fibrous tissue has undergone contracture and pulled the ciliary processes far centrally. No glaucoma is present. (Fig. 17A). An eye with persistent hyperplastic vitreous. The lens has undergone spontaneous absorption except for a translucent shrunken capsule in the upper part of the pupillary area. The iris is rich in blood vessels and these extend onto the fibrous tissue covering the pupillary area. There was intractible secondary glaucoma and the eye was enucleated. (Fig. 17B). The enucleated globe showing the hyaloid artery which could be traced to the disc. The lenticular remains shown in Figure 17A can be seen here in the pupillary area. The angle is obliterated by synechias. (Fig. 19). A case of bilateral persistent hyperplastic vitreous. In each eye the lens is shrunken to a small globular mass. Behind this is a fibrous tissue around the periphery of which are the ciliary processes. There is ectropion of the pigment epithelium of the iris.

Figure 16

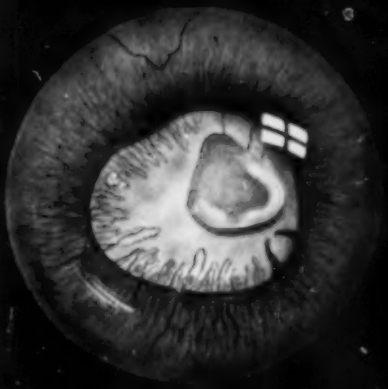
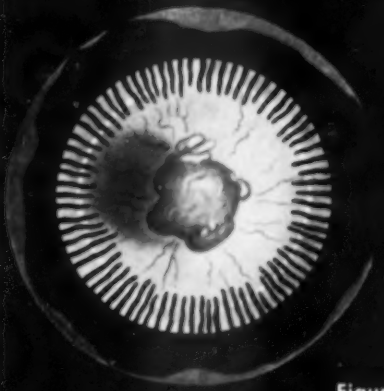


Figure 17 A

Figure 17 B



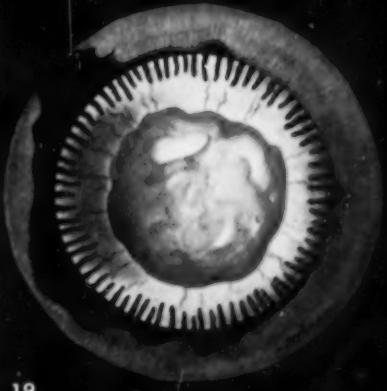


Figure 19

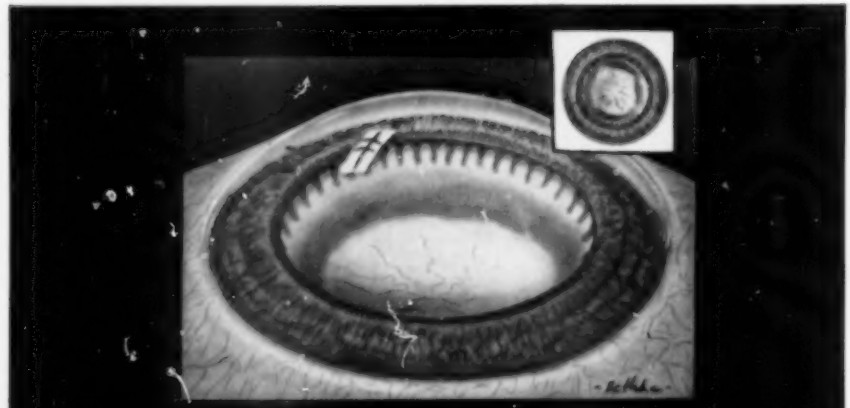


Figure 18 A

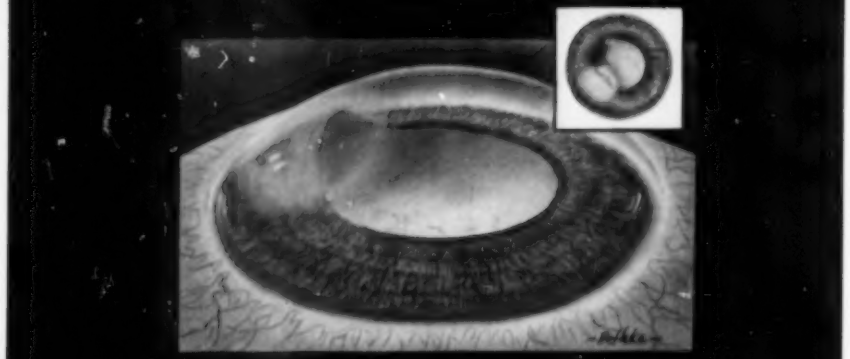


Figure 18 B

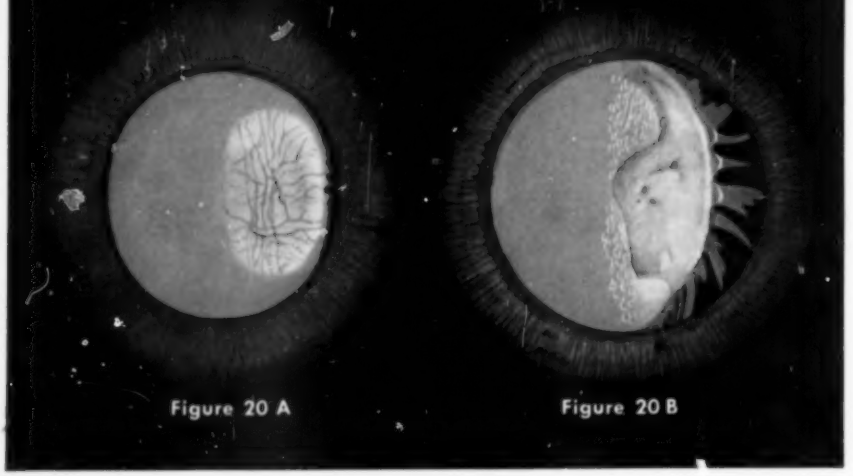


Figure 20 A

Figure 20 B

Iris bombé may occur from posterior synechias and promote glaucoma. If the glaucoma continues, buphthalmos ensues. These buphthalmic eyes frequently exhibit an opaque cornea due to the apposition of the lens and iris to its posterior surface. The globe may then proceed to atrophy, possibly with band keratopathy (figs. 10 and 14).

Natural history of the disease

In lesser degrees of the lesion, that is, when only a small patch of tissue lies along the posterior surface of the lens, the progressive changes noted are merely those secondary to contracture of the retrolental tissue. They manifest themselves by a gradual pulling of the ciliary processes further and further centrally and by a shrinkage of the lens. Therefore, cases with minimal changes may be seen in later life without serious complications. I have followed one such case from birth until the present time in a patient who is now 14 years old (fig. 20). This is the only case I have seen which has not developed complications leading to the loss of the eye except the treated cases and the three cases discussed in Group II, on page 328. However, these lesser manifestations of the disease are so rare that we can assume that the great majority of eyes affected with persistent hyperplastic vitreous are either enucleated because retinoblastoma is suspected or they undergo changes which lead to serious complications and usually to loss of the eye. Of course, persistence of the hyaloid artery and persistence of the pupillary membrane are seen in adult eyes, but I have never seen, nor has any colleague of whom I have inquired seen, a single case of uncomplicated full-blown persistent hyperplastic virtreous in an adult.

In the literature the only identifiable cases of persistent hyperplastic vitreous in adults, or in those approaching adult life, are the following: (1) Ruhwandl's case.[20] The patient was 31 years old and had a partial (area 3 to 4 mm. in diameter) persistent hyperplastic vitreous. (2) Lane's case.[29] The patient was 14 years old and had a partial (nasal one third of the lens involved) persistent hyperplastic vitreous. (3) Von Grolman's case.[11] The patient was 12 years old, and a spontaneous absorption of the lens had apparently taken place without corneal changes and without secondary glaucoma. (4) Vos's cases.[42] One patient was 20 years old. There was accompanying glaucoma for which enucleation was performed. Another patient was 17 years old. Here again glaucoma was present and an enucleation was performed. (5) Straub's case.[36] The patient was 20 years old and had a mild persistent hyperplastic vitreous with shrunken cataractous lens and hyaloid artery.

I have culled from the pathology collection of the Institute of Ophthalmology and the Armed Forces Institute of Pathology 10 globes which had been enucleated with the clinical picture of opaque cornea, band keratopathy, and secondary glaucoma (may be buphthalmos), but which from microscopic examination really proved to be instances of unrecognized persistent hyperplastic vitreous (figs. 21, 22, 23, and 24). I have personally followed five cases of persistent hyperplastic vitreous clinically from their early,

←

Figs. 18A, 18B, 20A, and 20B (Reese). (Fig. 18A). The right eye in a case of bilateral persistent hyperplastic vitreous. Hemorrhage can be seen around the periphery of the fibrous tissue. (Fig. 18B). Left eye of the same case as shown in Figure 18A. There are anterior synechias, corneal opacification, and secondary glaucoma. (Fig. 20A). A mild case of persistent hyperplastic vitreous followed for 14 years. There is an island of fibrovascular tissue on the posterior surface of the lens nasally. Several ciliary processes can be seen just inside of the pupillary margin. The patient was four days of age. At the age of four months a hemorrhage occurred over the surface of the fibrovascular tissue. The hemorrhage gradually absorbed. (Fig. 20B). The same eye shown in 20A, 14 years later. The fibrous tissue has contracted and pulled the ciliary processes more centrally where they are seen between the equator of the lens and the pupillary margin. The lens is partially cataractous adjacent to the fibrous tissue.

uncomplicated state to their sad culmination (figs. 10, 13, and 14). In the later stages the clinical picture merges into that common to other conditions (corneal scarring and glaucoma) and the correct basic diagnosis of persistent hyperplastic vitreous may not be made, or can be made only by surmise.

The course in cases of persistent hyperplastic vitreous seems invariably ill-fated for two reasons: (1) swelling of the lens due to a spontaneous rupture of the posterior capsule (see PATHOLOGY) and (2) spontaneous hemorrhage.

The swollen and cataractous lens leads to a narrowing or an obliteration of the filtration angle (figs. 4, 7, 12, 18, 21, 22, 23, and 24) and thus to secondary glaucoma. The lens, as well as the iris in front of it, protrudes toward the posterior corneal surface where if contact and adhesion occur, corneal edema and scarring ensue. If corneal contact is not made, there will be no secondary corneal changes, but there does occur complete or partial absorption of the lens with (fig. 17) or without (figs. 15 and 16) secondary glaucoma. The lens may absorb, partially or completely, leaving only a membrane which may harbor calcium or capsular remains. Or, the lens may shrink to a small, smooth, white, partially calcified, globular mass.

The spontaneous hemorrhage seems to occur around the fourth month after birth and may be of a minor degree with absorption (fig. 20) and no untoward sequelae. More often, however, hemorrhage is a serious complication which augurs ill for the prognosis (figs. 13, 18, and 25). The hemorrhage may be identified per se or it may be recognized by the presence of siderin in or around the retrolental tissue. Blood or its products may be appreciated inside the lens capsule or over the iris. More often than not, though, the occurrence of deep serious hemorrhage is seen only at operation when dark brown fluid and crystals exude. This deep vitreous and posterior chamber hemorrhage may lead to glaucoma, detachment of the retina, and/or eventual atrophy of the globe.

DIFFERENTIAL DIAGNOSIS

RETINOBLASTOMA

More than any other lesion, persistent hyperplastic vitreous simulates retinoblastoma and is, therefore, the condition most frequently confused with it. Most of the specimens of persistent hyperplastic vitreous for microscopic study are available because the eyes were enucleated with a mistaken diagnosis of retinoblastoma. The differentiating points are the following: (1) Microphthalmos is not present in retinoblastoma but is usually seen to some degree in persistent hyperplastic vitreous. (2) Persistent hyperplastic vitreous often manifests itself as a concave, opaque tissue just back of the lens. Retinoblastoma would never give this picture unless the vitreous were entirely filled with tumor tissue which lay against the posterior surface of the lens. (3) Eyes affected with persistent hyperplastic vitreous have abnormally shallow anterior chambers. Such is not the case with eyes affected with retinoblastoma. (4) Persistent hyperplastic vitreous almost invariably manifests long ciliary processes which are visible with the ophthalmoscope or by direct illumination. Eyes affected with retinoblastoma never show such a change. (5) Eyes affected with persistent hyperplastic vitreous develop cataractous changes, whereas eyes affected with retinoblastoma do not.

CONGENITAL CATARACT

If a patient with persistent hyperplastic vitreous is seen after the lens becomes partially or totally opaque, it may be impossible to diagnose the lesion from direct observation. From inference, however, a correct diagnosis can be made when a unilateral cataract occurs in a somewhat microphthalmic globe where there is a history of development of the cataract after birth. In addition, the presence of long ciliary processes

is pathognomonic. Lastly, the presence of a very shallow anterior chamber is substantiating evidence in favor of persistent hyperplastic vitreous.

Judging from the histories of patients with persistent hyperplastic vitreous whom I have seen clinically, as well as from the histories of the patients on whom microscopic sections showing persistent hyperplastic vitreous are available, I find that the original diagnosis has not infrequently been congenital cataract. The cataract was attacked surgically, and enucleation was performed only after one of several subsequent developments: (1) when the fibrovascular mass was later noted back of the lens and suspected of being a retinoblastoma; (2) when the nature of the dense fibrous mass encountered back of the lens was not appreciated and therefore was not handled properly surgically, and complications such as hemorrhage and secondary glaucoma occurred; or (3) when too many unsuccessful attempts were made to effect an adequate opening in the tissue.

Retrolental fibroplasia

It is rare for a case of retrolental fibroplasia to be confused with persistent hyperplastic vitreous. Retrolental fibroplasia is seldom purely unilateral. In almost every case some evidence of the sequelae of an active retrolental fibroplasia can be seen in the fellow eye at the periphery of the fundus when the patient is examined under general anesthesia. Occasionally, however, there do occur cases of retrolental fibroplasia in which no evidence of the disease can be seen in the fellow eye. Twice I have been unable to say with certainty that such cases were not instances of persistent hyperplastic vitreous, the difficulty being due to the fact that the affected eye in both diseases is somewhat microphthalmic, ciliary processes are visible, and the anterior chamber is shallow.

Prematurity, of course, seems to indicate retrolental fibroplasia, but the disease does occur in infants with normal birth weights, and there is no reason why persistent hyperplastic vitreous could not occur in a premature infant. In persistent hyperplastic vitreous the ciliary processes are seen because they are abnormally long and they are also incorporated in the periphery of the retrolental tissue.

In retrolental fibroplasia the normal-appearing ciliary processes are seen because the contracting retrolental tissue drags the ciliary body centrally and the processes are seen in relief against the light background of the fibrous tissue. The processes are not incorporated in the periphery of the tissue. In cases of retrolental fibroplasia an accompanying cataract is almost unheard of, and when such cataractous changes do occur, they are usually in the form of localized vacuoles at the equator of the lens adjacent to the most severely involved sector of the fundus. By contrast, in persistent hyperplastic vitreous cataract is common and begins at the posterior pole.

There comes a time in the late stages of persistent hyperplastic vitreous when the clinical picture merges into that common to the late stages of other conditions. Then there is seen a partially or totally opaque cornea with or without secondary glaucoma, or with or without atrophy or phthisis of the eye. In the final stages of such ophthalmic wrecks it is sometimes impossible to state what underlying basic pathologic condition led to the terminal stage.

Retinal dysplasia

This condition is bilateral in mentally retarded infants or in young children manifesting multiple congenital anomalies.[29]

Departures from the usual clinical picture

Persistent hyperplastic vitreous, as interpreted and depicted in this report, is a well demarcated entity. There are, however, rare cases of persistent hyperplastic vitreous which exhibit unusual features.

In this category is a group of cases in which there is an accentuation of the hyaloid component (figs. 28a and 28b) whereby a large stalk of vascularized tissue extends backward from the lens. These cases show varying degrees of retinal detachment and opaque white tissue around the disc. The retinal detachment is frequently seen as folds above and below the disc region, the larger fold usually being below. At other times the disc site may be obscured by white tissue which prevents a clear appraisal. The persistent hyperplastic vitreous element in this type of case is often minimal so that some view of the interior is possible. Three cases in this report belong to this group, and there are other such cases in the literature (Weve,[44] Wiedersheim and Herzog,[45], Snell,[24] Salffner,[21] Hervouet,[14] Hoffmann,[17] Holm[18]).

Another rare allied group is characterized by the association of persistent hyperplastic vitreous with an iris coloboma (figs. 27a and 27b). The persistent hyperplastic vitreous element and usually the associated hyaloid artery are located on the posterior lens surface corresponding to the coloboma sector. One of the four cases lent by Dr. Bertha Klien belongs in this category and showed a most unusual feature—the presence of melanoblasts in the retrolental fibrovascular tissue. Cases in the literature belonging to this group are those of Hess[15] (two cases), de Vries,[43] Eversbusch.[7]

Persistence of the primary vitreous in other conditions

In any severely malformed eye (marked microphthalmos with or without colobomas of the tunics, cyclopea, and so forth), persistence of the primary vitreous with or without hyperplasia may be present. Also, in retinal dysplasia there are usually some remains of the fibrovascular sheath on the posterior surface of the lens.

Treatment of persistent hyperplastic vitreous

On the premise that the natural course of the disease is a retrograde one, the objective of any contemplated therapy should be (1) to preserve the eye, (2) to salvage any vision that might be present, and (3) to combat any complication, such as glaucoma, that has already arisen.

It is true that eyes with persistent hyperplastic vitreous invariably show some esotropia (and occasionally exotropia), but this need not be considered a surgical problem of the disease.

In order to preserve the eye, the surgical objective is to handle satisfactorily the problem of the swollen lens before it produces serious and irreversible complications. In order to obtain the potential vision of the eye, an adequate opening must be made in the retrolental tissue. The problem of hemorrhage presents itself in two ways: (1)

→

Figs. 21, 22, 23, and 24 (Reese). (Fig. 21). An eye with persistent hyperplastic vitreous enucleated because it became blind, uncomfortable, and disfiguring. The partially absorbed lens and iris are in contact with the cornea. Back of the lens is a fibrovascular sheath into which the ciliary artery enters. There are peripheral synechias. The presence of persistent hyperplastic vitreous was not appreciated before enucleation as the basic cause of the disease. (AFIP No. 188, 158.) (Fig. 22). An eye with persistent hyperplastic vitreous enucleated with a clinical diagnosis of advanced buphthalmos. There is a partially absorbed lens back of which is a fibrovascular sheath with long ciliary processes inserting into it. The iris is against the posterior surface of the cornea. There are secondary corneal changes. The hyaloid artery was present in other sections. (Fig. 23). An eye with persistent hyperplastic vitreous enucleated because it was blind, uncomfortable, and disfiguring. There is an almost completely absorbed lens back of which is the fibrovascular sheath with the hyaloid artery inserting into it. The anterior chamber is obliterated and there are secondary corneal changes. Persistent hyperplastic vitreous was not suspected before enucleation. (AFIP no. 96,585.) (Fig. 24). A blind disfiguring eye not suspected of having persistent hyperplastic vitreous before enucleation. The partially absorbed lens is adherent to the posterior surface of the cornea. There is a thick fibrovascular tissue into which the hyaloid artery inserts. (AFIP no. 211,920.)

Figure 21

Figure 22

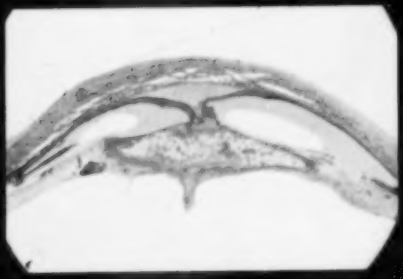


Figure 23

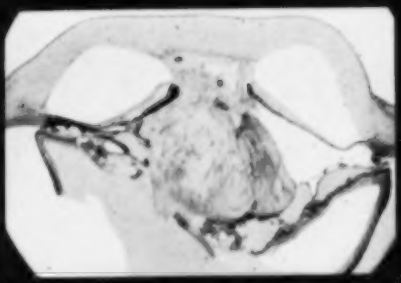


Figure 24

Figure 25

Figure 26

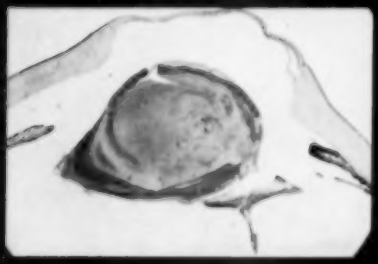


Figure 27 A

Figure 27 B

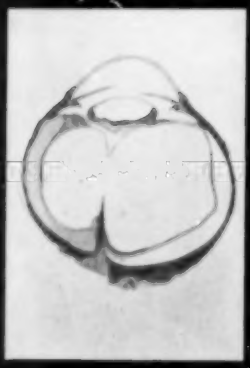


Figure 28 B

Spontaneous deep hemorrhage (fig. 25) is responsible for the loss of some of these eyes, and about this there seems to be nothing that can be done. This deep hemorrhage is appreciated at the time of surgery when old dark blood, with or without crystals and siderin, emerges from the posterior chamber. (2) Fresh, and maybe pulsating, hemorrhage may occur when the vascular fibrous sheath is cut. Usually this is moderate in amount and absorbs readily. It is surprising how negligible hemorrhage is when one considers the vascular nature of the tissue. It is true that occasionally a brisk pulsating hemorrhage occurs at the time of the discission, especially when the tissue is very thick, and this may lead to organization and secondary closure of the opening, as well as more serious complications.

The cases in this series fall into five separate surgical groups:

I. The early uncomplicated cases which should result in a good pupillary opening after a needling followed by a discission.

II. The cases in which there has been a spontaneous absorption of the lens and only the retrolental tissue remains; no secondary glaucoma; no secondary corneal changes.

III. The cases which have shown evidence of deep spontaneous hemorrhage.

IV. The cases which have been erroneously diagnosed as congenital cataract and have been unsuccessfully operated on by the usual surgical procedures employed in these cases.

V. The cases that have had no treatment but in which the natural course of the disease has led to glaucoma.

These five groups will be separately discussed.

I. Early uncomplicated cases

The procedure here is to remove the lens by one or more needling operations and then to do a discission through the fibrovascular tissue. The lenses in eyes affected with persistent hyperplastic vitreous are rather small, and, therefore, one needling usually suffices to accomplish complete absorption. The eye is ready, then, for the final discission in from four to six months' time. In these cases the thickness of the posterior fibrovascular sheath varies considerably (figs. 5, 6, 7, and 8) from a rather thin fibrous membrane to a tissue with a thickness even greater than that of the lens. Furthermore, this tissue may, in rare instances, contain cartilage (fig. 8). We must approach this fibrovascular tissue, therefore, with the sharpest cutting instrument available, and I know of none to compare in this regard with the Grieshaber discission knife made after the type designed by Wheeler. With such a knife, which must be exquisitely sharp, a vertical incision is made through the tissue. Because of tension from contracture, the tissue usually retracts markedly after being cut, even to the point where it lies behind the iris and leaves a round black pupil (figs. 29a and 29b). The thicker the retrolental tissue, the less it seems to re-

←

Figs. 25, 26, 27A, 27B, and 28B (Reese). (Fig. 25). An eye enucleated because it was a retinoblastoma suspect. There is evidence of old hemorrhage with organization and contracture. Back of the lens is persistent hyperplastic vitreous occupying the funnel of the completely detached retina. (Fig. 26). An eye with persistent hyperplastic vitreous enucleated because it was a retinoblastoma suspect. There is complete absorption of the lens with only the fibrovascular tissue remaining. The hyaloid artery can be seen coursing for a short distance posterior to the tissue. (AFIP no. 169,162). (Figs. 27A and 27B). Persistent hyperplastic vitreous associated with a coloboma of the iris and other congenital anomalies. The left eye of a Negro infant who died at the age of two months. There were multiple congenital anomalies throughout the body. (Fig. 27A). A section at one level to show the posterior fibrovascular sheath with the hyaloid artery inserting into it. (Fig. 27B). A section at another level to show this tissue extending through an iris coloboma to the posterior surface of the cornea. The fibrovascular sheath shows densely pigmented melanoblasts. (Specimen lent through the kindness of Dr. Bertha A. Klien.) (Fig. 28B). Case in which the hyaloid component predominates. Section of an eye with a lesion similar to that seen in Figure 28A (next plate). (AFIP no. 543,207).

tract, so that in the eyes with the thickest tissue the opening may be only a slit. The hyaloid artery enters the retrolental tissue nasal to the center so that the discission, in order to avoid the artery, should be made carefully in the center and certainly with no deviation nasally. The type of discission which has been employed is that recommended by Wheeler except that instead of one sweeping motion, several, slower, sawing motions are desirable.

Postoperatively, there is a tendency to the formation of posterior synechias, even though careful measures may have been taken to obviate them. The iris in these cases is usually rich in blood vessels, and synechias are known to form even when no surgical procedure has taken place. Especially after surgery, and particularly in the period following the needling operation, careful attention should be given to the use of mydriatics. If synechias are present when the discission is made, and if the pupil is adherent with a small diameter, the discission should include a bit of the sphincter area of the iris (fig. 30). Sometimes it seems well nigh impossible to prevent the formation of synechias.

I have treated, in the manner described, 16 eyes belonging to Group I. Eleven of the eyes have black pupils (figs. 29, 30), the fundus details are sharply seen, and the fundi appear normal. A hyaloid artery is seen in four of the eyes. One case was a failure; the eye manifested old brown blood during the operation, indicating deep hemorrhage, and intractable glaucoma ensued. On four eyes the surgery has not been completed: (1) In one some oozing of blood covered the newly established pupillary opening and led to a thin pupillary membrane. Another discission will be necessary. (2) In another the lens matter has been dissipated by a needling and the eye is now ready for a discission. (3) In two a needling has been done and we are now waiting for lens absorption.

From the microscopic study of eyes with persistent hyperplastic vitreous we know that the retina is in situ and that it apparently contains all its normal elements. Furthermore, the fovea seems well formed. Therefore, these eyes are expected to be capable of reasonably good vision. We have obtained vision as good as 15/20 in one case (fig. 30), but usually it is from 10/200 to the counting of fingers with the aphakic correction. Some of our patients are too young to co-operate. Moreover, I am sure some of the reduced vision can be attributed to disuse from obstruction of the pupillary area and the resulting tropia. Although the affected eye is somewhat smaller than its fellow eye, there seems to be no excessive amount of hyperopia present. It is my feeling that these eyes have the capacity to develop better vision through use.

II. Spontaneous absorption of lens with only the posterior fibrovascular sheath remaining, and no serious complications such as glaucoma or secondary corneal changes

We have had only three of these cases (figs. 15, 16) because usually complications develop which lead to loss of the eye. Two

Figs. 28A, 29A, 29B, and 30 (Reese). (Fig. 28A). Case in which the hyaloid component predominates. (Fig. 28A). A small disc of opaque tissue is seen just posterior to the lens and from this the hyaloid artery courses toward the disc. A vertical retinal fold extends across the disc. (Fig. 29A). An eye with persistent hyperplastic vitreous after almost complete disappearance of the lens following a needling. Around the periphery of the fibrovascular tissue are the ciliary processes. This is the appearance of the eye just before the discission was made. (Fig. 29B). The appearance of the eye after the discission showing that the fibrous tissue retracted to such a degree that a round black pupil is present. The fundus is normal except for the hyaloid artery which is depicted in the drawing extending from the disc to the nasal part of the fibrous tissue which has retracted back of the pupil. The clinical appearance of this eye before surgery is shown in Figure 9. (Fig. 30). An eye with persistent hyperplastic vitreous after surgery. The insert shows the vertically oval black pupil. From the nasal side of the pupil the hyaloid artery extends posteriorly to the disc. Otherwise the fundus is normal. Vision, 15/20 with aphakic correction.

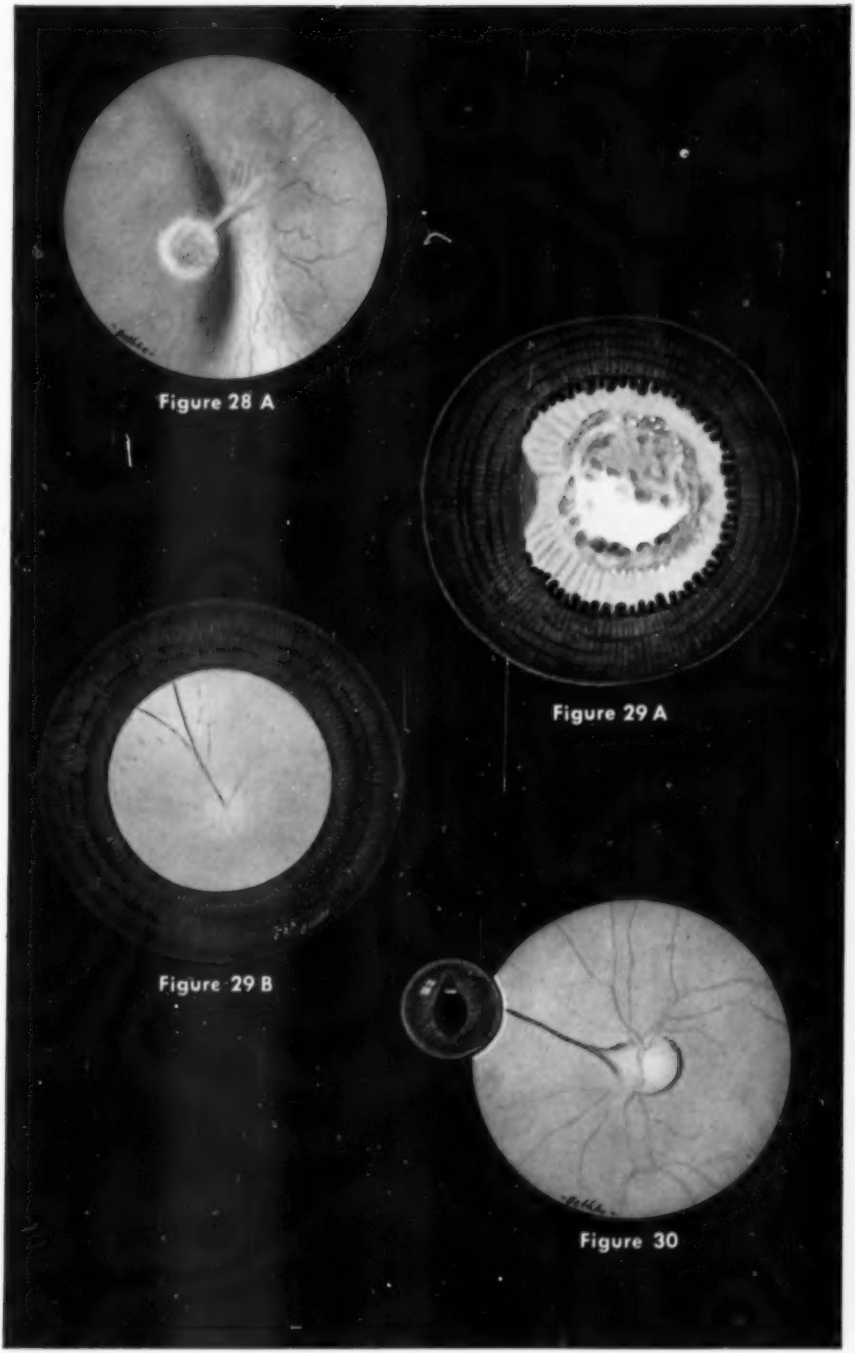


Figure 28 A

Figure 29 A

Figure 29 B

Figure 30

of the cases have had a discission performed in the manner described for the first group. In each case a good opening was obtained. The fundi have a normal appearance and one shows a hyaloid artery. The visual results are the same as in Group I. The third case has not had a discission to date.

III. Deep spontaneous hemorrhage

Hemorrhage occurring before operation may be seen as such; it may be manifested in one of its successive changes, such as siderin or crystals; or the presence of old hemorrhage may be noted at the time of operation when dark blood, siderin, or crystals escape. Whenever there has been evidence of past deep hemorrhage in the eye, we have not had a successful outcome. There are nine cases in our series which fall into this group. Four of these cases were bilateral.

IV. Erroneous diagnosis (congenital cataract)

One of our patients was said to have had a congenital cataract for which several operations had been performed. It is difficult to determine from the history exactly how many operations were done and of what nature they were. When the child was seen two years after the last operation for "congenital cataract," buphthalmos was present. The pressure was reduced to normal by a cyclodiathermy operation.

Another patient was said to have had a congenital cataract, and four operations (the nature of which was unknown) had been performed in an effort to remove the "cataract." When we saw the patient, the posterior fibrovascular sheath was present. A discission was done. This resulted in a black pupil through which the fundus appears to be normal.

V. Untreated cases ending in glaucoma

This group includes six patients with persistent hyperplastic vitreous for which no treatment was given even though in some cases it had been advised. Subsequently, because of lens swelling, glaucoma had ensued with or without corneal scarring. Three patients in this group underwent cyclodiathermy operations and three had enucleation.

The 14 eyes which have been successfully operated on (11 in Group I, two in Group II, and one in Group IV) have shown no subsequent deterioration. Eight of the 14 are now six months to two years and six are two to four years following the last operation. The 11 cases in Group I were probably saved from the secondary glaucoma and corneal changes which would have developed subsequent to lens swelling. The two successful cases in Group II weathered the natural hazards of the disease and were left with only the fibrovascular sheath covering an aphakic pupil. The same holds true for the one case salvaged in Group IV.

I have found only two references in the literature to a premeditated surgical plan to cope with persistent hyperplastic vitreous. One was by Collins,[3] who sites two cases thought to be unilateral congenital cataract in which the tissue could not be cut but was dislocated or couched. He later identified the condition as persistent hyperplastic vitreous and advocated needling of the lens, to be followed later by displacement or couching of the retrolental tissue. The other was by Wolfe,[16] who advocated removal of the lens and cutting or dragging the tissue free of the pupillary area.

It is possible that the surgery we have undertaken which consisted of eliminating the lens and making an opening in the fibrovascular sheath, had no effect on whether or not the eye would suffer deep, spontaneous hemorrhage. The possibility, however, that the surgery obviated so-called spontaneous hemorrhage in some instances cannot be disregarded. We know that the fibrovascular sheath undergoes progressive contracture and that in time it becomes avascular. The constant and progressive contracture of this tissue leads to tremendous traction on the ciliary processes. These processes, as well

as the ciliary body and iris, are abnormally congested with blood vessels. It is likely that this constant traction on the ciliary processes is what eventually leads to hemorrhage. The relief of this traction by the discission made through the fibrous tissue may be a factor, therefore, in preventing such hemorrhage. The fact that there has been no hemorrhage or other complications following successful surgery seems to bear this out.

Summary

The clinical appearance of persistent hyperplastic primary vitreous is bizarre and sometimes unrecognized.

The clinical course, which is constantly changing leads to complications and loss of the eye.

The eyes are enucleated because (1) of suspicion of retinoblastoma, (2) of intractable glaucoma, (3) of unsightly appearance from corneal scarring and atrophy of the globe. Frequently eyes with persistent hyperplastic vitreous can be salvaged by surgery.

73 East 71st Street (21).

The drawings were made by Mr. Gustave Bethke. The sections, excepting those from the Armed Forces Institute of Pathology, were prepared by Mr. Edward Gonzales.

I am indebted to the above for their help and to the Armed Forces Institute of Pathology for the use of their material which has been duly acknowledged in the legends. Also, I am most appreciative of the help rendered by Miss Lilly Kneiske.

References

1. Collins, E. Treacher: Developmental deformities of the crystalline lens. J.A.M.A., **51**:1051-1056 (Sept.) 1908.
2. ———: On the development and abnormalities in the zonule of Zinn. Roy. London Ophth. Hosp. Rep., **13**:81-96 (Dec.) 1890.
3. ———: Pseudo-glioma. Roy. London Ophth. Hosp. Rep., **13**:361-394 (Dec.) 1892.
4. Cordes, F. C.: Types of congenital cataract. Am. J. Ophth., **30**:397-420 (Apr.) 1947.
5. Czermak, W.: Pseudophakia fibrosa, eine faserige Scheinlinse, hervorgegangen aus der Tunica vasculosa lentis. Arch. f. Augenh., **57**:79-96, 1907.
6. Dötsch, A.: Anatomische Untersuchung eines Falles von Mikrophthalmus congenitus bilateralis. Arch. f. Ophth., **48**:58-91, 1899.
7. Eversbusch: Ein eigenthümlicher Fall von Arteria hyaloidea persistens und Coloboin der Iris. Ber. ü d. Versamml. d. Ophth. Gesellsch. Heidelberg, **15**:168, 1883.
8. Findlay, E. K.: Congenital membranous cataract. Am. J. Ophth., **8**:216-218, 1925.
9. Gifford, S. R. and Latta, J. S.: Pseudoglioma and remains of the tunica vasculosa lentis. Am. J. Ophth., **6**:565-571 (July) 1923.
10. Ginsberg, S.: Ueber embryonale Keimverlagerung in Retina und Centralnervensystem, ein Beitrag zur Kenntniss des Netzhautglioms. Arch. f. Ophth., **48**:92-122, 1899.
11. Grolman, W. von: Ueber Mikrophthalmus und Cataracta congenita vasculosa, nebst einigen Bemerkungen über Drüsen der Chorioidea und Neubildung von Linsenkapsel. Arch. f. Ophth., **35**:187-198, 1899.
12. Hamma, A.: Beitrag zur Kenntnis der Pseudogliome. Arch. f. Augenh., **67**:183-196, 1910.
13. Heine, L.: Angeborene Bindegewebsmasse hinter der Linse mit Art. hyaloid. pers. ein Gliom vortäuschend. Ztschr. f. Augenh., **58**:194-196, 1926.
14. Hervouet, M. F.: Persistance d'une artère hyaloide revêtue de tissus rétiniens embryonnaires. Bull. et mém. Soc. franç. d'opht., **65**:437-441, 1952.
15. Hess, C.: Zur Pathogenese des Mikrophthalmus. Arch. f. Ophth., **34**:147-194 (Nov. 13) 1888.
16. Hippel, E. von: Arteria hyaloidea persistens, in Henke-Lubarsch Handbuch der pathologischen Anatomie. Berlin, Julius Springer, 1931, v. 11, pt. 2, pp. 66-71.
17. Hoffmann, H.: Ueber eine seltene Strangbildung im Augenhintergrund (Arteria hyaloidea persistens). Klin. Monatsbl. f. Augenh., **77**:370-379, 1926.
18. Holm, E.: An anomaly of the papilla nervi optici with arteria hyaloidea persistens. Acta Ophth., **1**:66-67, 1923-1924.
19. Hudson, A. C.: Subluxation of lens and persistent posterior vascular sheath of lens in an infant aged two months. Proc. Roy. Soc. Med., **22**:24-25, 1928.
20. Lane, F.: Persistent posterior fibrovascular sheath of the lens: a report of two clinical cases, and three eyeballs examined microscopically. Arch. Ophth., **48**:572-580, 1919.
21. Leech, V. M.: Persistent posterior fibrovascular sheath of the lens caused by fetal iritis. Arch. Ophth., **4**:332-337 (Sept.) 1930

22. Lent, E. J., and Lyon, M. B.: Persistence of embryonic fibrovascular sheath of the crystalline lens. Am. J. Ophth., **5**:706-711, 1922.
23. Marshall, J.: Congenital anomaly: persistence of the tunica vasculosa with subsequent buphthalmos. Tr. Ophth. Soc. U. Kingdom, **44**:176-182, 1924.
24. Paganelli, T. R.: Pseudo-glioma in a child of three weeks. J. Ophth., Otol. & Laryng., **32**:298-301 (Sept.) 1928.
25. Parsons, J. H.: Microscopical section of pseudo-glioma, due to congenital membrane behind the lens. Tr. Ophth. Soc. U. Kingdom, **22**:253-254, 1902.
26. ———: Sections from a case of microphthalmos. Tr. Ophth. Soc. U. Kingdom, **22**:258-260, 1902.
27. Pollock, W. B. I.: Case of pseudoglioma due to persistence and thickening of the posterior fibrovascular sheath of the lens. Tr. Ophth. Soc. U. Kingdom, **43**:263-272, 1923.
28. Reese, A. B.: Persistence and hyperplasia of primary vitreous; retrolental fibroplasia—two entities. Arch. Ophth., **41**:527-549 (May) 1949.
29. Reese, A. B., and Blodi, F. C.: Retinal dysplasia. Am. J. Ophth., **33**:23-32 (Jan.) 1950.
30. Ruhwandl, F.: Ausgedehnte Reste der fötalen Augengefässe. Ztschr. f. Augenh., **15**:245-247, 1906.
31. Salffner, O.: Bulbus septatus. Arch. f. Ophth., **54**:552-562, 1902.
32. Sanders, T. E.: Pseudoglioma. Am. J. Ophth., **35**:61-66, 199-213, 364-369, 1952.
33. Seefelder, R.: Die Missbildungen des menschlichen Auges, in Kurzes Handbuch der Ophthalmologie. Berlin, Julius Springer, 1930, v. 1, pp. 519-630.
34. Snell, S.: Remains of hyaloid artery. Tr. Ophth. Soc. U. Kingdom, **4**:349-350, 1884.
35. Steffen, R.: Ueber einen Pseudolenticus posterior. Klin. Monatsbl. f. Augenh., **109**:176-179, 1943.
36. Straub, W.: Beitrag zur Klinik der persistierenden Glaskörperarterie. Ophthalmologica, **121**:194-200, 1951.
37. Terry, T. L.: Extreme prematurity and fibroblastic overgrowth of persistent vascular sheath behind each crystalline lens: I. Preliminary report. Am. J. Ophth., **25**:203-204 (Feb.) 1942.
38. ———: Fibroblastic overgrowth of persistent tunica vasculosa lentis in premature infants: II. Report of cases—clinical aspects. Arch. Ophth., **29**:36-53 (Jan.) 1943.
39. ———: Fibroblastic overgrowth of persistent tunica vasculosa lentis in infants born prematurely: III. Studies in development and regression of hyaloid artery and tunica vasculosa lentis. Am. J. Ophth., **25**:1409-1423 (Dec.) 1942.
40. ———: Fibroblastic overgrowth of persistent tunica vasculosa lentis in premature infants: IV. Etiologic factors. Arch. Ophth., **29**:54-65 (Jan.) 1943.
41. ———: Ocular maldevelopment in extremely premature infants. J.A.M.A., **128**:582-585 (June) 1945.
42. Vos, Tj. A.: Embryonale Synechiebildung zwischen Augenbecherrand und Linse. Klin. Monatsbl. f. Augenh., **96**:452-466, 1936.
43. de Vries, W. M.: Ueber eine Missbildung des menschlichen Auges (Coloboma iridis, Katarakt, Stränge und Gefässe im Glaskörper). Arch. f. Ophth., **57**:544-570 (Feb.) 1904.
44. Weve, H.: Congenital aphakia with hyaloid artery and retinal fold. Ophthalmologica, **97**:79-80, 1939.
45. Wiedersheim, O., and Herzog, W.: Ueber Pseudogliom und Gliom (zur Frage der Entstehung des malignen Retinoblastoms). Arch. f. Ophth., **153**:273-288, 1952.
46. Wolfe, O. R.: Surgical treatment of perilenticular membranes in children. J. Internat. Coll. Surgeons, **21**:650-665, 1954.

Ophthalmic Miniature

Socrates: People may injure their bodily eyes by observing and gazing on the sun during an eclipse, unless they take the precaution of only looking at the image reflected in the water, or in some similar medium.

Plato: *Dialogues of Socrates.*

HYPERPHORIA AND SOME OF ITS PROBLEMS*

THE ETTA JEANÇON MEMORIAL LECTURE

BEULAH CUSHMAN, M.D.
Chicago, Illinois

In his early work with the squint patient, Alexander Duane outlined a logical and sensible approach to the diagnosis. His methods are clearly explained in his translations of Fuchs' *Textbook of Ophthalmology*,[2] his papers and monograph. James W. White followed in Duane's footsteps, working with him up to his death, and then continuing in the muscle field until, at the time of his passing, he had gained for himself the reputation of being "the muscle authority." Perhaps there are a few who would take exception to granting him this title; however, the many confusing techniques and results associated with the other methods of the treatment of squint only point up more sharply why White's invaluable contributions in the field of strabismus have established his position of authority.

His approach to the problem is simple and requires little equipment outside of a thorough understanding of the anatomic, physiologic and functional characteristics of the muscles. The diagnostic routine examination is arranged in such a way that a vertical and lateral anomaly can be carefully calculated, resulting in a complete muscle diagnosis. Then the possibility of proper operative care is a definite reality instead of the mere chance that always exists when the cosmetic approach is used as the basis of all muscle surgery.

Neither Duane nor White left a completed book for their students to follow but each did leave a number of discussions and papers. After reading the many confusing books on the subject, it is wonderful to get their approach and follow their reasoning through, making the whole problem in the management of squint so much more simple and satisfactory for the physician as well as for the patient.

Their analysis emphasized the importance of making a diagnosis of the ocular muscle anomaly before any attempt at treatment is carried out, surgical or nonsurgical. White, in 1932, presented a classic paper on hyperphoria.[6] He discussed the importance of diagnosing not just the lateral imbalance alone or the vertical imbalance alone but combining the diagnosis to cover the entire muscle problem. This is a large field, and as this paper will deal only with some phases of vertical anomalies, the lateral imbalance will be included in the diagnosis but not in the discussions.

As no physician attempts to treat headache, albumin, or even glaucoma without an etiologic diagnosis, as far as possible, so vertical anomalies should not be treated according to the "hyper" found in eyes front. Dr. White emphasized in the paper referred to earlier[6] that the measurements in eyes front are not enough to make a diagnosis; these are only the symptoms that something is wrong. The measurements in the diagnostic positions of gaze are necessary before the individual muscle anomaly can be evaluated. Ocular muscle problems are not static; they are progressive, although they often tend to become comitant in time. This must be understood in order to be able to interfere at a time when the treatment will alleviate or help to permit a cure. Any palliative treatment, even with glasses or prisms, should not be used until the diagnosis is made and the outline of treatment decided upon.

Misleading descriptive terms such as innervational hyperphoria, alternating hyper-

* From the Department of Ophthalmology, Northwestern University Medical School. Read before the Los Angeles Society of Ophthalmology and Otolaryngology, February 3, 1955.

phoria, and dissociated vertical divergence should not be used in a diagnosis. Head-tilt in a certain direction to signify an ocular muscle imbalance should also be disregarded unless an anomaly of an individual muscle or muscles can be found in the six cardinal fields of gaze to account for it.

A neurologic squint is a term used by White to denote a type of squint in which the measurements decrease and increase as the examination is being made. The measurements may vary a great deal at repeated examinations so that no consistent diagnosis can be reached. This type of squint is often, though not always, found in the retarded child; and as the muscle diagnosis is not definite, surgery is contraindicated.

An hereditary tendency for refractive problems, as well as for muscle anomalies, is a common finding, and a complicated refractive error is so frequently found with the muscle anomalies that the study of the refractive problems must always receive a most important place in our approach to the muscle problem. The retraction syndrome, strabismus fixus, fibrosis of the medial or lateral rectus muscles, are all congenital anomalies and are not necessarily associated with refractive problems; whereas, the squints which appear after a few months or in the early years of life may be associated with complicated refractive errors, accommodative factors, or anisometropia. A squint present at birth occurs less frequently, and if present is usually one with the more marked muscle anomalies.

Duane and White, in all of their papers, and Dr. White in his clinical work, emphasized squint as a developing condition which tends to become comitant. Vision, likewise, is a developing process. At two or three weeks of age an infant follows a light steadily and at six weeks can follow a light binocularly. At six months, binocular vision can be demonstrated. It is usually not till the age of seven or eight or even 10 years, however, that so-called normal vision 20/20 is found. Vision improves as fixation develops, and the ocular muscles seem to adjust themselves to a pattern according to their innate possibilities with the fixation.

Keiner in his monograph,[8] in 1951, correlated some of the early developmental anomalies of vision with oculomotor anomalies as a form of "myelogenesis retarda" and he felt that between the group of blind infants with severe disturbances such as papilla griesa of Beauvieux, and the group of squinting children (classed as having slight disturbances) there existed a gradual difference. He felt it was obvious to seek the cause of the affection in both groups in a more or less retardation of the normal development of the tracts and connections of certain parts of the central nervous system.

He stated that "all children are born with a potentiality to squint and almost total disassociation of the two eyes.

"Strabismus cannot occur until the light stimulus is able in connection with the stages of development of reflex paths to produce motor effect. Strabismus may develop at a very early age, the highest frequency of the earliest cases was in the first six months, and in 54 percent the condition was evident by the end of the first year and in 78 percent by the end of the second year. After this the frequency dropped off rapidly and only occasionally did a case appear after the sixth year."

An embryologic study of the eye muscles gives some interesting possibilities in the variations of the anlages as well as their development. This may help to explain the term, congenital paresis, as described by White. The four rectus muscles to each eye arise from the apex of the orbit around the optic foramen and extend forward and outward, attaching themselves to the sclera anterior to the equator a definite distance for each one from the limbal area. The superior and inferior oblique to each eye extend mainly from in front of the eyeball backward, attaching themselves at or behind the equator.

It is interesting to note, in comparative-

anatomy studies, that the anlages for the superior, inferior, and medial rectus as well as the inferior oblique develop from the embryonal premandibular cavity and all are supplied by the third nerve.[6] These muscles can be recognized by the 20-mm. stage of the fetus (six to seven weeks). There are two patients in my series who showed retardation in development of this group of muscles, one associated with ptosis, in the other a pseudoptosis which disappeared after surgery for the muscle anomaly.

The superior rectus grows forward and outward at an angle of 25 to 26 degrees, attaching itself 7.7 mm. from the limbus. At the 60-mm. stage (11 weeks) the inner one third of the superior rectus separates to become the levator. By the 75-mm. stage (12 to 13 weeks) the levator has grown laterally and higher. A small anlage might produce a weak superior rectus as well as a weak levator. Clinically a weakness of the two muscles, superior rectus and levator, is found frequently combined as congenital ptosis.

The mandibular head cavity carries the anlage for the superior oblique, and each muscle grows forward to extend from the trochlear process and attach itself at or behind the equator and with it grows the fourth or trochlear nerve. The number three head cavity contains the anlage of one muscle, the lateral rectus and its nerve, the abducens.

Tenon's capsule is first recognized anteriorly at the 80-mm. stage (13 to 14 weeks) as a thin sheet of differentiating tissue and is seen posteriorly at the 150-mm. stage (five months).

The paresis of the superior rectus as is found so frequently, may be associated with its division during development in forming the levator. In his thesis for the American Ophthalmological Society in 1933,[7] White reported a paresis of the superior rectus in 6.5 percent of 6,000 patients. In 1938, White and Brown reported an associated vertical anomaly in 715 patients of 1,062 cases studied.[8] Of this group the superior rectus was underactive in 507 patients, the inferior rectus in 121 patients, the inferior obliques 20 times and superior obliques 13 times. Bilateral involvement of the developmental anomalies, as of the superior rectus muscles, is so common that it should be suspected when an underaction of one is found. A weakness of the superior rectus was found in 68 patients out of 137 cases we recently studied in whom 88 had vertical anomalies (and 24 of these 68 were bilateral). Of the vertical anomalies 19 were of the inferior rectus, and of these seven had bilateral involvement. There was one patient with paresis of each inferior oblique and one with bilateral paresis of each superior oblique.

In watching many of the squints develop, an inequality of the elevators will become noticeable very early in life because of the small child's necessity to look up from his low stature; whereas, the underaction of the depressors is much later in showing up due to the limited use of the lower visual field. A slight head-tilt compensates a great deal for the discomforts of an inferior rectus anomaly.

The diagnostic positions or cardinal fields of gaze can be described as eyes right, eyes up and right, eyes down and right; eyes left, eyes up and left, eyes down and left. The right lateral rectus and left medial rectus function coordinately to pull both eyes to the right. The right superior rectus and the left inferior oblique bring the eyes up and right; the right inferior rectus and left superior oblique take the eyes down and right. The same situation is found in eyes left. The left lateral rectus and right medial rectus work in this field; the left superior rectus and right inferior oblique take the eyes up and left; the left inferior rectus and right superior oblique work in eyes down and left. These muscles, then, function in pairs and are called yoke muscles. The action of these yoke muscles can be observed in the cardinal fields by use of the screen comitance. This is a test Dr. White emphasized

strongly as an aid to the diagnosis of vertical imbalances in which the fixation complicates the entire picture.

A paresis is a weakness or underaction of an individual muscle. For each underaction there are two overactions. For example, an underaction of the right superior rectus will always bring about an overaction of the left inferior oblique. This overaction is called secondary deviation and is found only in the yoke muscle. Another overaction, called the secondary contracture, is found in the right inferior rectus. The paresis or underaction of a muscle is the primary factor—the overactions are secondary and occur in the yoke muscle as a deviation and in the direct antagonist to the underacting muscle as a contracture.

As the superior rectus is the most common type of vertical muscle paresis observed, it will be the first anomaly discussed. When a difference in level is measured in eyes front by the use of the screen test, no muscle diagnosis can be made until the examiner carefully checks the primary fields of action of all vertical muscles. This will usually point to an increase of the vertical deviation in one field.

In the case of a right superior rectus paresis, the secondary deviation of the left inferior oblique will cause the left hyperphoria in eyes up and right. The left hyperphoria in eyes down and right is caused by the secondary contracture of the right inferior rectus. In some instances the same amount of vertical can be measured in the field of the secondary deviation and the secondary contracture. This is the point at which the screen comitance proves valuable. By dissociating the eyes with the screen, the actual elevation power of the right superior rectus can be determined. When the left eye is the eye preferred for fixation in eyes up and right, the left vertical is controlled somewhat and the left inferior oblique never becomes as overactive as it would if the right eye were the fixing eye. The left hyperphoria is very apt to measure more in the lower right field in these cases as the secondary contracture many times shows more vertical measurement. If the right eye were the fixating eye, the left hyperphoria would be more marked in the upper right field, as the secondary deviation of the left inferior oblique would be total. The secondary contracture of the right inferior rectus in this case would be less.

Fixation is a complicated part of the entire muscle picture, but the more it is studied the easier it is to understand and diagnose those cases of squint that are of long standing. The way the eyes are used and the functions of the muscles in these patients become fixed, so that many times a vertical deviation can be entirely camouflaged by certain fixation habits. If the same routine examination is followed and the screen test and the screen comitance done routinely, the examiner will be able to understand fixation and will be able successfully to explain and diagnose the many so-called peculiar muscle problems. A child with a squint which has only recently been observed is a good example to study. The diagnosis in these early cases of squint is not so confusing. By studying the fixation of these patients, it is easy to see how certain visual habits are established and how they will confuse the whole muscle picture in a few years.

The next most common vertical muscle anomaly is that of paresis of the inferior rectus. From experience, an anomaly of the inferior rectus is often found to be the basic factor in divergence problems. In children with a divergence excess the examiner makes certain of a correct vertical diagnosis and then operates at least before the child starts to school. It is advisable to operate on the divergence excess before the near-point of convergence starts to recede. Merely observing the patient because the imbalance is still a phoria is a mistake; for as the squint becomes manifest, more surgery than originally necessary will have to be done to correct the progressing convergence insufficiency.

The occurrence of inferior oblique or superior oblique paresis is not too infrequent. These are not rare anomalies but may be more evident in appearance.

The terms phoria and tropia are the same as far as treatment is concerned. The condition is usually only a matter of degree, but the patient with a phoria has many more disagreeable symptoms than the patient with a tropia. The measurements for a phoria may be just as great as for a tropia, but binocular vision is maintained by the patient with a phoria most of the time for distance or near or in some part of the field of vision.

If a diagnosis can be made of the muscle anomaly at the time it is a phoria, the results are much more satisfactory if the condition is corrected before binocular vision is lost and the tropia is allowed to progress. Some imbalances will never become manifest but will always carry the discomforts and symptoms of a phoria. Sometimes the tropia does not develop until much later in life, as when accommodation begins to lessen or with some general health problems. Visual acuity, refractive errors, aniseikonia, anisometropia, as well as any combination of these factors affects the loss of binocular vision and the development of the tropia. Results can be obtained after a tropia develops, but the results are much better if we can do what is necessary before binocular vision is lost.

To produce the best vision possible in each eye is our first responsibility, and the use of glasses is an important part of the treatment, but it is just as important to know when to reduce or remove the glasses when a muscle problem is present in order to stimulate fixation in each eye and progress with the diagnosis and treatment. Many convergent squints are improved with their prescribed plus lenses, but few clear up altogether with this treatment. Frequently the convergence excess is partly accommodative combined with a secondary divergence insufficiency or it may be a nonaccommodative convergence excess and a vertical anomaly. To leave a plus lens on for a period of years in hope that the plus will correct the convergence problem is poor, ill-advised treatment. The entire problem is composed of more than just one part—the vertical imbalance being one important part, and the accommodation, another. Years of continued treatment with an increased plus lens is not in order as the only result may be a reduced accommodation along with a complicated vertical imbalance that is much more difficult to diagnose.

Vertical imbalances are an interesting part of the study of individual muscle anomalies. They can be complex and confusing or very clear-cut and simple. They are usually in combination with a lateral imbalance—convergent or divergent. Occasionally an isolated vertical imbalance will be found, but this is usually in the younger patients before the secondary conditions have become established.

With the eyes parallel, binocular single vision is almost spontaneous.[4] Many times it takes a few months to a year after the proper surgery before binocular vision becomes stable. In some patients it may even take longer than that; but if the muscle problem has been approached in a diagnostic way and surgery outlined from the functional standpoint, then there is no reason that good binocular vision cannot be anticipated. There is no need for postoperative exercises or orthoptic treatment. This merely complicates any existing problem. Orthoptic treatment is not a cure for poor diagnosis and incorrect surgery.

The routine examination of the muscle patient is clear and simple. If the examiner will follow it, with practice the confusing picture of muscle anomalies that exists in the minds of many eye physicians today will be cleared. This concept of the routine examination has to be understood before the vertical muscle anomalies can be correctly diagnosed. It is only with the proper diagnosis that successful vertical surgery can be a reality.

Case reports

Case 1

The first patient showed no manifest muscle anomaly when she first came in at the

age of eight years with symptoms of dizziness and headaches while in school and after reading or viewing television. General health examination, negative.

Eye examination. Visual acuity, without correction, was: R.E., 20/25; L.E., 20/25. Refraction (no glasses ordered) was: R.E., +1.5D. sph. ⌒ +0.5D. cyl. ax. 90°; L.E., +1.5D. sph. ⌒ +0.5D. cyl. ax. 90°. Accommodation was normal: R.E., 5.0 cm.; L.E., 5.0 cm. (without glasses). The screen test showed no imbalance for distance or near. The N.P.C. was 60 mm. Excursions: No underactions or overactions were seen.

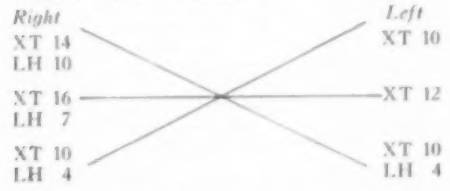
The child was free of symptoms during the summer months. After starting back to school in September the same symptoms became incapacitating. Again the general examination was negative. At this time vision was: R.E., 20/20; L.E., 20/20, but the screen test showed an exophoria at near of 30Δ and the near-point of convergence had receded to 80 mm. The other findings were as follows and a diagnosis was made after prolonged occlusion:

Maddox rod
sc X 1 *6M* X 30 *25cm*
Screen comitance: Slight underaction left medial rectus.
Fixation: RE dominant *6M* and *25cm*
Prism convergence: 50ΔB.O. *25cm* (forced)
Treatment: Prolonged occlusion LE advised to try to uncover more lateral imbalance and a possible vertical imbalance.

After six days' occlusion, left eye:

Muscle balance
Screen test
sc X 12 X 20+
LH 5 *6M* LH 7 *25cm*

Diagnostic positions of gaze



N.P.C.: 130 mm (LE); can be forced to 50 mm.
Screen comitance: Slight underaction left medial rectus. Underaction right superior rectus; secondary deviation left inferior oblique.
Diagnosis: Paresis right superior rectus
Convergence insufficiency secondary to vertical
Surgery: Recession left inferior oblique 3.5 mm
Resection left medial rectus 5.5 mm+

Surgical correction was not accepted at this time. These findings were again corroborated after the summer vacation, and the surgical correction again was advised.

The symptoms of discomfort disappeared immediately following the operation and she continued in school with no discomfort. Eight months following and to date, six years later, she has been comfortable, and the screen test and findings show a normal muscle balance and a cure.

Eight months postoperative:

Muscle balance
Screen test
sc Slight X *6M* X 8–10 *25cm*

Diagnostic positions of gaze

N.P.C.: 50 mm (LE)
Prism convergence: 15ΔB.O. *6M*
45ΔB.O. *25cm*

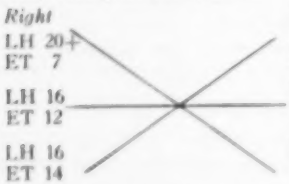
CASE 2

L. G., aged five years, had shown a convergent squint since birth and a head-tilt. The visual acuity was equal in each eye, indicating it was an ocular muscle imbalance that she had had since birth, with binocular single vision in a part of the visual field present with the head-tilt. The imbalance was a partial third nerve extraocular paresis which involved the right superior rectus and right inferior oblique.

Eye examination. Visual acuity, without correction, was: R.E., 20/50−1; L.E., 20/50−1. Refraction showed: R.E., +1.5D. sph. ⌒ +0.25D. cyl. ax. 90°; L.E., +1.5D. sph. ⌒ +0.75D. cyl. ax. 90°.

Muscle balance
Screen test
sc LH 18+
ET 8 *6M & 25cm*

Diagnostic positions of gaze



N.P.C.: 35 mm (RE) sc

Screen comitance: Complete loss of elevation right inferior oblique; secondary deviation left superior rectus not marked because of left fixation eyes left and up & left; second contracture right superior oblique marked. Underaction right superior rectus; secondary deviation left inferior oblique; secondary contracture right inferior rectus.

Fixation: Prefers LE eyes front and in fields; can alternate easily.
Binocular single vision with head tilt to right shoulder.

Diagnosis: Double elevator paresis, right eye

Surgery: Resection right inferior oblique 4.0 mm and 10.0 mm advancement (with transplant of Tenon's capsule)
Recession left inferior oblique 7.0 mm

The individual muscles are operated upon according to the field of greatest measurements—the condition re-evaluated before each step.[18]

Two years postoperative:

Screen test
sc E 4 *6M & 25cm*
N.P.S.: 40 mm (RE)
Excursions: Vertical has quieted down; slight X in fields.
No head tilt.
Worth 4 dot: Binocular single vision *6M & 25cm*

Resection of the inferior oblique[8a] has not been reported often; and the few times we have done it, it has given satisfactory results in the complicated picture. These marked developmental anomalies must be watched carefully for many years.

CASE 3

M. P., one of three sisters who developed a divergence early in life, showed a divergence at intervals at the age of three years, but no definite diagnosis could be made of a hyperphoria although there was a suspected right hyperphoria in the distance. Findings five years later were of an exotropia for distance, but she still was able to use the eyes together for close work, but the near-point had receded from 60 to 120 mm.

Screen test
sc X 30
RH varies *6M* X 18 *25cm*
N.P.C.: 60 mm (RE) sc
Excursions: No marked underactions or overactions.

Five years later:

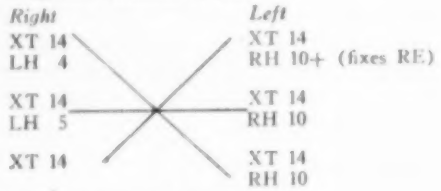
Visual acuity	*Refraction*
sc RV 20/25+1	R.E., +1.0D. sph. ⊂ +0.5D cyl. ax. 90°
LV 20/25+1	L.E., +1.0D. sph. ⊂ +0.5D. cyl. ax. 90°

Muscle balance

Screen test

sc X–XT 81		X 16	
RH 9	*6M*	RH 3	*25cm*

Diagnostic positions of gaze



N.P.C.: 120 mm (LE) sc

Screen comitance: Underaction left superior rectus; secondary deviation right inferior oblique. Slight underaction right superior rectus. Left lateral rectus slightly more overactive than right.

Fixation: Prefers RE *6M;* binocular single vision *25cm.*

Diagnosis: Primary divergence excess
Secondary convergence insufficiency
Paresis right and left superior rectus

Surgery: Recession left lateral rectus 5.5 mm
Recession right lateral rectus 4.5 mm
Recession right inferior oblique 3.0 mm

One year postoperative:

Screen test
sc X 2 *6M* X 2–4 *25cm*
N.P.C.: 85 mm (LE)
Excursions: No vertical imbalance in fields
Fixation: Binocular single vision eyes front and in fields
Prism convergence: 15ΔB.O. *25cm*

CASE 4

B. P., sister of M. P., had been noticed

to have a left divergence since the age of four years:

Eye examination: Visual acuity, without correction, was: R.E., 20/16−2; L.E., 20/16−2. Refraction showed: R.E., +1.5D. sph. ⌒ +0.5D. cyl. ax. 90°; L.E., +1.5D. sph. ⌒ +0.5D. cyl ax. 90°.

Muscle balance

Screen test

sc X 20 (varies) X 12
LH 2-3 *6M* LH sl. *25cm*

Diagnostic positions of gaze

N.P.C.: 105 mm (RE) sc

Screen comitance: Right lateral rectus slightly more overactive than left. Suspect weakness right superior rectus.

Fixation: Binocular single vision eyes front.

Treatment: Near point exercises advised.

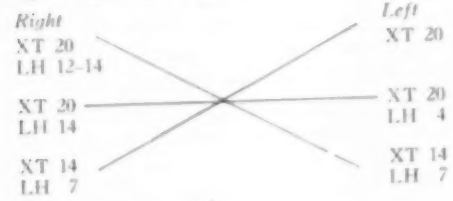
One year later—after prolonged occlusion of the left eye for nine days:

Muscle balance

Screen test

sc XT 20 XT 20
LH 7 *6M* LH 4 *25cm*

Diagnostic positions of gaze



N.P.C.: 110 mm (RE) sc

Screen comitance: Left lateral rectus more overactive than right. Right medial rectus slightly weak. Underaction right superior rectus; secondary deviation left inferior oblique.

Fixation: Prefers LE eyes front.

Diagnosis: Primary divergence excess
Secondary convergence insufficiency
Paresis right superior rectus

Surgery: Recession right lateral rectus 5.0 mm
Recession left lateral rectus 5.5 mm
Recession left inferior oblique 3.5 mm

One year postoperative

Screen test

sc X 10 *6M* X 8 *25cm*

N.P.C.: 85 mm (RE) sc

Excursions: No vertical imbalance in fields

Fixation: Binocular single vision eyes front and in fields.

Prism convergence: 20ΔB.O. *25cm*

CASE 5

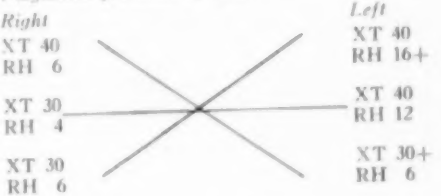
D. W., aged six years, had shown a divergent squint since the age of three years and glasses for the anisometropia did not improve her appearance but the vision was satisfactory. Refraction showed: R.E., −0.75D. sph. ⌒ +3.25D. cyl. ax. 100° = 20/50; L.E., −0.25D. sph. ⌒ +4.25D. cyl. ax. 65° = 20/50−2.

Muscle balance

Screen test

cc XT 30 X-XT 30-50
RH 14 *6M* RH 10 *25cm*

Diagnostic positions of gaze



N.P.C.: 60 mm (LE) cc—recedes to remote

Screen comitance: Left lateral rectus overactive. Underaction left medial rectus. Underaction left superior rectus; secondary deviation right inferior oblique. Suspect underaction right superior rectus.

Fixation: Prefers RE eyes front

Diagnosis: Divergence excess
Secondary convergence insufficiency
Paresis left superior rectus

Surgery: Recession left lateral rectus 4.0 mm+
Resection left medial rectus 5.5 mm+, advance 1.5 mm
Recession right inferior oblique 5.5 mm+

Following the first surgical procedure the cosmetic appearance was satisfactory, and she had binocular single vision for one to one and one-half years. Then a right hyperphoria was evident again with the greatest measurement in the field of the right inferior rectus. Three years postoperative—patient

complains of reading difficulties in school; also occasional dizziness.

Visual acuity

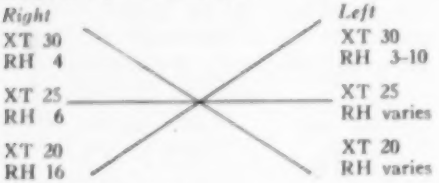
cc RV 20/20 + 4
LV 20/25 + 3

Muscle balance

Screen test

cc X 20 X 35
RH 14 *6M* RH 12-14 *25cm*

Diagnostic positions of gaze



N.P.C.: 55 mm (LE) cc

Screen comitance: Underaction right medial rectus. Underaction right inferior rectus; secondary deviation left superior oblique.

Fixation: Binocular single vision eyes front cc

Diagnosis: Secondary convergence insufficiency
Paresis right inferior rectus

Surgery: Resection right medial rectus 5.5-6.0 mm
Resection right inferior rectus 6.0-6.5 mm

This patient was seen many times until we were sure of the findings and the diagnosis was definite.

CASE 6

Our next patient, G. L., was treated for a divergence excess and a right superior rectus paresis. First, she was given glasses for the anisometropia and treatment for the left amblyopia. She measured a left hyperphoria in eyes front, and the left hyperphoria showed the greatest increase in the field of the right superior rectus. A right hyperphoria was found in the field of the left superior rectus, but no surgery was done for this at the first step since the marked preference for right fixation masked the true amount of vertical in this field.

Eye examination. Visual acuity, without correction, was: R.V., 20/25+2; L.V., 20/200. Refraction (glasses ordered) showed: R.E., +0.75D. cyl. ax. 90° = 20/20−2; L.E., −1.0D. sph. ⊃ +5.5D. cyl. ax. 75° = 20/70−2.

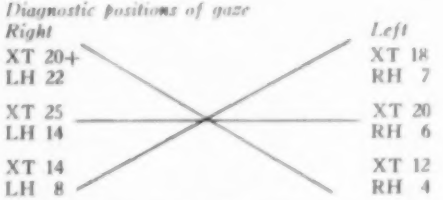
After three weeks amblyopic treatment with complete patch, R.E., vision in L.E. improved to 20/50−1.

Muscle balance

Screen test

cc XT 16 XT 30
LH 3 *6M* LH 5 *25cm*

Diagnostic positions of gaze



N.P.C.: 110 mm (LE) cc—can be forced to 60 mm

Screen comitance: Left medial rectus weaker than right. Underaction right superior rectus; secondary deviation left inferior oblique. Suspect underaction left superior rectus; secondary deviation right inferior oblique.

Fixation: Prefers RE eyes front

Diagnosis: Divergence excess
Secondary convergence insufficiency
Paresis right and left superior rectus

Surgery: Recession left lateral rectus 3.5 mm
Resection left medial rectus 5.5 mm
Recession left inferior oblique 7.0 mm

The patient was comfortable and had binocular single vision for one and one-half years following the first surgical correction. Then she came in complaining of headaches and recurrence of the divergence. At this time the right hyperphoria showed up very clearly, and the diagnosis of a left superior rectus paresis was made and surgery outlined. However, she was found to have a vascular hypertension, the etiology to be determined and treatment instituted before the second surgical step was done for the paresis of the left superior rectus.

Two years postoperative:

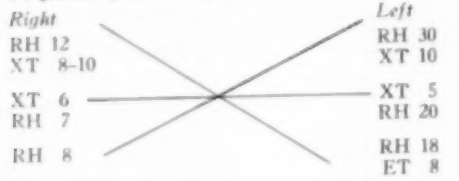
Wearing: R.E., +0.5D sph. ⊃ +0.25D. cyl. ax. 105° = 20/15
L.E., −1.5D. sph. ⊃ +6.5D. cyl. ax. 70° = 20/50−2

Muscle balance

Screen test

cc RH 25 *6M* RH 25
X 8 *25cm*

Diagnostic positions of gaze



N.P.C.: 80 mm (LE) with vertical adjustment
Screen comitance: Underaction left superior rectus; secondary deviation right inferior oblique.
Diagnosis: Paresis left superior rectus
Surgery: Recession right inferior oblique 7.0 mm

CASE 7

Our next patient, a man aged 33 years, with 20/20 vision in each eye, using the right eye in his left field and left eye in his right field, wanted cosmetic improvement. The overaction of each superior rectus was the most marked finding and it was only after a number of examinations that we finally determined that the paresis of each inferior rectus was the primary underaction.

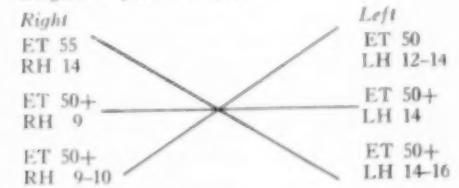
Refraction: R.E., +1.0D. sph.
L.E., +1.0D. sph.

Muscle balance

Screen test

sc ET 65	ET 55	
RH 10	RH 12	
LH 14	*6M* LH 14	*25cm*

Diagnostic positions of gaze



N.P.C.: 70-80 mm (RE) sc
Screen comitance: Underaction each inferior rectus; secondary deviation each superior oblique; marked secondary contracture each superior rectus. Underaction each lateral rectus.
Fixation: *Alternates easily 6M & 25cm*
Prefers RE eyes left & LE eyes right
Diagnosis: Divergence insufficiency
Paresis right and left inferior rectus
Surgery: Resection right lateral rectus 10.0 mm+
Resection left lateral rectus 10.0 mm+
Resection right inferior rectus 6.0 mm
Resection left inferior rectus 6.0 mm

The cosmetic appearance was greatly improved after the first step as indicated by the screen test.

One month postoperative:

Screen test
sc E-ET 8
Slight double hyper *6M & 25cm*
N.P.C.: 110 mm (RE) sc
Worth 4 dot: Prefers LE eyes front
Binocular single vision momentarily

This patient was from a great distance and could stay no longer in this country. He did promise to return; and if there is any trouble further surgery may be necessary. However, a little help is often all that is necessary if the problem is approached in this manner; and time, with reflex changes, takes care of any remaining imbalance. As long as the measurements continue to be so much decreased[18] further surgical steps should be delayed.

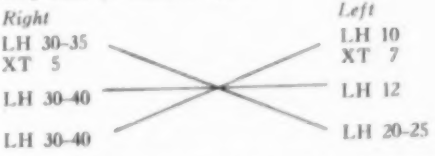
CASE 8

The next patient, a man aged 49 years, complained of diplopia for many years with increasing discomfort the past five years with the onset of presbyopia. Visual acuity, without correction, was: R.E., 20/33−2; L.E., 20/25+1; Refraction showed: R.E., −1.0D. sph. ⌒ −0.5D. cyl. ax. 105°; L.E., −0.5D. sph. ⌒ −0.5D. cyl. ax. 105°.

Muscle balance

Screen test
sc LH 10 *6M* LH 30 *25cm*

Diagnostic positions of gaze



N.P.C.: 60 mm (LE) sc—with vertical adjustment
Screen comitance: Underaction right superior rectus; secondary contracture right inferior rectus. Suspect underaction left inferior rectus.
Fixation: Prefers RE eyes front and in fields.
Head tilt to right and slightly back.
Diagnosis: Paresis right superior rectus
Paresis left inferior rectus

Surgery: (first step)
Recession left inferior oblique 6.0 mm

The finding of a superior rectus paresis in one eye and of an inferior rectus of the other eye is most unusual, and we approached this problem by taking care of the most marked underaction first, which was the right superior rectus paresis for which a recession of the left inferior oblique[7a] was done.

The patient was seen every month during the following year. He had been told before the first step that a second would be necessary; but six months to a year must be allowed to get the best results possible from the first step, and therefore he wanted to wait until his yearly vacation came. The examination at that time was as follows:

One year postoperative:

Muscle balance

Screen test

sc LH 5 *6M* LH 25 *25cm*

Diagnostic positions of gaze

N.P.C.: 90 mm (RE) sc—with vertical adjustment.

Screen comitance: Underaction left inferior rectus; secondary deviation right superior oblique.

Diagnosis: Paresis left inferior rectus

Surgery: (second step)
Resection left inferior rectus 7.0 mm

One month postoperative:

Screen test

sc Very slight LH *eyes front*

N.P.C.: 65 mm (RE) sc

Excursions: Motility appears good.

Worth 4 dot: Binocular single vision *6M & 25cm*

Prism convergence: 15ΔB.O. *25cm*

Bifocals ordered:

R.E., −1.0D. sph. ⊃ −0.5D. cyl. ax. 105°
L.E., −0.5D. sph. ⊃ −0.5D. cyl. ax. 105°, add: +2.25D.

The bifocals have been comfortable, which is one of the best tests for comfortable binocular single vision.

CASE 9

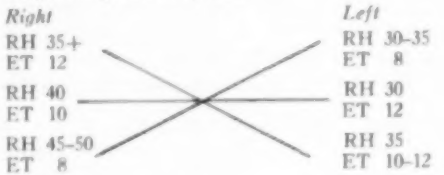
Mrs. M. S., aged 45 years, had had a convergent squint and right hyperphoria since childhood, and she had found that by using her right eye for fixation the squint was much less noticeable, also if she wore strong lenses. She had been fairly comfortable with this arrangement until the onset of presbyopia. Visual acuity, without correction, was: R.E., 20/50−1; L.E., 20/25+2. Refraction showed: R.E., +2.5D. sph. ⊃ +0.5D. cyl. ax. 180° = 20/20−3; L.E., +1.5D. sph. ⊃ +0.25D. cyl. ax. 90° = 20/20−2, +1.75, add. = L 4 pt. O.U.

Muscle balance

Screen test

cc RH 35 RH 38
ET 7 *6M* ET 12+ *25cm*

Diagnostic positions of gaze



N.P.C.: 90 mm (LE) cc

Screen comitance: Marked underaction right inferior rectus; secondary deviation left superior oblique; secondary contracture right superior rectus.

Fixation: Prefers RE eyes front; alternates easily.

Diagnosis: Paresis right inferior rectus

Surgery: Resection right inferior rectus 7.0 mm—advance 3.0 mm

This surgery was advised as the first step, and she was told one or two other steps would be necessary at six-month intervals.

Four months postoperative:

Muscle balance

Screen test

cc ET 16 ET 16
RH 16+ *6M* RH 25+ *25cm*

Diagnostic positions of gaze

N.P.C.: 75 mm (LE) cc

Screen comitance: Motility of weak right inferior rectus improved; secondary deviation left superior oblique; secondary contracture right superior rectus.

Surgery: (second step)
Recession left superior oblique 7.0 mm
Recession right superior rectus 3.0 mm

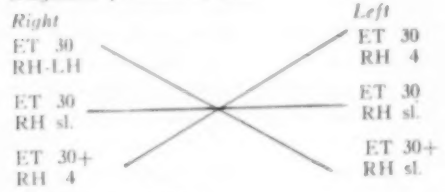
Six months postoperative:

Muscle balance

Screen test

cc ET 20		ET 25	
RH 2	*6M*	RH 2	*25 cm*

Diagnostic positions of gaze



N.P.C.: 60 mm (LE) cc

Screen comitance: Underaction left lateral rectus.

Diagnosis: Divergence insufficiency

Surgery: Resection left lateral rectus 10.0 mm advance 2.0 mm (third step)

A divergence insufficiency measuring an ET 20[1a] for distance usually requires only one lateral rectus to be resected; then the weaker one is done, and if it is very weak it is also advanced.

Two years postoperative:

Muscle balance

Screen test

cc ET 12		ET 16	
RH 4	*6M*	Slight RH varies	*25cm*

Diagnostic positions of gaze

N.P.C.: 65 mm (LE) cc

Worth 4 dot: Prefers RE *6M*
Momentary binocular single vision *25cm*

Comment: Patient wears bifocals with comfort.

A movie* was shown to demonstrate underactions with the secondary deviations and secondary contractures, as well as the variation in the appearance of the squint according to the fixing eye.

25 East Washington Street (2).

* From the Ocular Muscle Clinic, Northwestern University Medical School.

References

1. Cushman, B., and Saro, L.: Vertical anomalies. Quart. Bull. Northwestern University Medical School, **22**:17, 1948.

1a. Cushman, B., and Willard, R. L.: Maximum and minimum resections and recessions. Am. J. Ophth., **38**:547 (Oct.) 1954.

2. Duane, A.: Fuchs' Textbook of Ophthalmology. Philadelphia, Lippincott, 1911, ed. 4, pp. 679-768.

3. Keiner, G. B. J.: New Viewpoints in the Origin of Squint. The Hague, Matinus Nijhoff, 1951.

4. LeConte, J.: Sight. (The International Scientific Series.) New York, Appleton, 1897.

5. Mann, I.: Development of the Human Eye. London, Cambridge Univ. Press, 1928, pp. 253-255.

5a. McLean, J. M.: Direct surgery of underacting oblique muscles. Tr. Am. Ophth. Soc., **46**:633, 1948.

6. White, J. W.: Hyperphoria. Arch. Ophth., **7**:739-747, 1932.

7. ———: Paresis of the superior rectus. Tr. Am. Ophth., **31**:551, 1933. Soc., 1933, vol. 31, p. 551.

7a. ———: Surgery of the inferior oblique at or near the insertion. Tr. Am. Ophth. Soc., **40**:118, 1942.

8. White, J. W., and Brown, H.: The occurrence of vertical anomalies associated with convergent and divergent anomalies. Tr. Am. Acad. Ophth., 1938, pp. 329-336.

THE EFFECT OF LOCAL CORTISONE ON WOUND HEALING IN RABBIT CORNEAS*

E. S. Palmerton, M.D.
Rapid City, South Dakota

Introduction

One of the prominent physiologic effects of cortisone is its suppressing influence on the response of mesenchymal tissue to trauma or other insult.[1] It is felt that, as far as the collagen diseases are concerned, the beneficial effects of cortisone, hydrocortisone, and ACTH are due to this mesenchymal influence rather than to electrolyte balance and metabolic effects.

The widespread use of cortisone in ophthalmology promptly led to questions about the possible deleterious effects of this agent on the healing of wounds in the eye. Some could see no contraindications to the local use of cortisone.[2] Others,[3] noting reports of failure of other than ocular tissues to heal and to resist infection when under the influence of cortisone, have warned that the reparative and defense powers of the eye might be impaired.

Since many eye injuries cause corneal damage and much eye surgery is done through corneal or limbal incisions, it has seemed important to study the behavior of wounds in corneal tissue, in the presence of cortisone. The stroma comprises about 90 percent of the thickness of the cornea. The rate of metabolism of the corneal stroma is relatively low and it is normally avascular. Firm healing at best is not rapid for the stroma.[4] Vail[5] states that a corneal incision is not well healed for two or more months.

There have been a number of reports about the influence of cortisone on the healing of corneal injuries. Ashton and Cook,[6] working with rabbits, found that subconjunctivally injected cortisone inhibited wound healing. They noted more profound inhibition when larger doses were used and stated: "formation of the fibrous coagulum, cellular infiltration, fibroblastic repair, and endothelial regeneration" were suppressed.

Newell and Dixon[7] found a definite failure of keratoblastic proliferation in the wounds of experimental corneal grafts treated postoperatively with cortisone. Sheppard,[8] after observations made on cortisone treated eyes of rabbits that had been subjected to cyclodiathermy and cyclodectrolysis, advised against the use of cortisone immediately after ocular surgery, as the normal responses of healing were retarded and he felt an infection could be masked. He suggested that if cortisone were used, an antibiotic should be given at the same time.

McDonald and co-workers[9] studied the ocular effects of hydrocortisone and found marked suppression of fibroblastic growth, with only rudimentary efforts at invasion of the fibrous coagulum. Yasuna, et al.[10] investigating the effects in rabbits of systemic cortisone, incised the corneas and after varying postoperative intervals tested the bursting strengths of the eyes by injecting fluid into the anterior chambers. No significant difference was found between the strengths of the treated eyes and the control eyes. Histologic studies of the same corneas showed a slight delay in fibroblastic proliferation in the the eyes of animals treated with cortisone, as compared with the controls.

I have studied the effects of locally applied cortisone on the healing of experimental corneal wounds in rabbits. The tensile strengths of the wounds were investigated with a traction apparatus similar to one suggested by Brown and Nantz.[11]

Procedure

This work was done in two parts. First, incised wounds were made in the rabbit

* From a thesis written in partial fulfillment of the requirements for the degree of Master of Science in Ophthalmology, University of Minnesota.

corneas and the right eyes were treated postoperatively with drops of saline, and the left eyes were treated with cortisone suspension—a combination of drops and subconjunctival injections being used. At varying intervals after making the wounds, the animals were killed and the eyes tested before enucleation for the tensile strengths of the wounds. The eyes were then enucleated and sections were made from a number of the corneas for histologic study.

In the second part of the project, similar incisions were made, and the right eyes were treated with drops of cortisone suspension, while the left eyes received subconjunctival injections. After one week all the animals were killed, the eyes enucleated, and sections were made of the corneas for study in an attempt to compare the intensity of the effect of the drops versus the subconjunctival injections on healing.

All sections were stained with hematoxylin and eosin. Cortone (cortisone acetate suspension) was furnished by Merck and Company.

Experiments: Part I

Each rabbit was anesthetized with ether after receiving sedative doses of pentobarbital sodium intraperitoneally. Just before each eye was operated upon it was prepared by the instillation of several drops of a two-percent solution of tetracaine, and the area about the eye was carefully cleansed with a colorless tincture of benzalkonium chloride.

Both right and left corneas of each animal were incised. The incisions were five-mm. long and were made with a von Graefe knife through the entire thickness of the cornea, so that aqueous was lost and the anterior chamber in each instance became flat. A preplaced mattress suture of 6-0 silk was then tied so as immediately to close the incision. Other sutures, which were later to serve as traction sutures, were placed in certain corneas above and below the incisions. Mention of these traction sutures will be made later. In each case the anterior chamber soon reformed with the sealing of the incision with the prompt coagulation of the rabbit aqueous.

The control eye in each case was then left undisturbed for 24 hours, but each left eye was immediately given a subconjunctival injection of about 1.5 mg. of cortisone suspension, and the animal was returned to its cage. No dressings were used and the lids were not sutured.

Twenty-four hours after surgery a regime of eye drops was started. The right eyes got drops of saline. The left eyes received drops of a cortisone suspension in saline, strength approximately 8.3 mg. per cc. These drops were given six times a day.

The eyes were tested as follows: Group I, after three days; Group II, after five days; Group III, after seven days; and Group IV, after 14 days. Each animal just before testing was killed with an overdose of pentobarbital sodium intraperitoneally.

The main testing apparatus was an analytical balance with the windows of the case removed for easier manipulation. The weighing pan to the operator's left was removed for testing a rabbit's right eye, and the weighing pan to the operator's right taken off for testing a left eye. To balance for the removal of the weighing pan, small bottles were hung from the beam of the balance. In the other weighing pan was placed a small metal cup into which water was dripped during the testing. Before each eye was tested the scale (with bottles hanging from the beam on one side, the weighing pan with the water cup on the other side) was balanced by adding sufficient water to the little bottles (fig. 1). A loop of thread was also hung from this side. The freshly killed rabbit was then placed so that the eye to be tested was directly under the loop of thread (fig. 2).

The eye of the rabbit, previously prepared with a liberal canthotomy, was secured as shown in Figure 3. The upper traction suture was carefully tied to the loop hanging from the beam of the balance. The lower

Fig. 1 (Palmerton). Shows the balance with one weighing pan removed, ready for a test on a right eye. The small bottles for balancing the apparatus are shown, as is the loop of thread to be tied into the upper traction suture of the cornea.

traction suture was tied to another loop which in turn was fixed to a point on the floor of the balance case. After these sutures had been tied to their respective loops the mattress suture across the corneal incision was cut and gently removed. By following this scheme carefully the eyes received a minimal amount of manipulation before testing.

Water was then dripped into the metal pan in the remaining weighing pan of the balance, to cause an upward pull on the upper traction suture. The rate of dripping in the water was kept at about 10 cc. per minute.

The end-point was usually quite abrupt and consisted of a sudden spreading apart

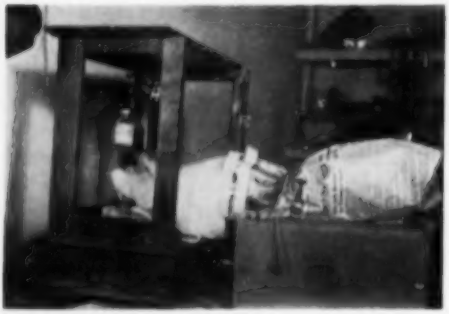


Fig. 2 (Palmerton). Shows the prepared right eye, with traction sutures tied to their respective loops. Animal freshly killed.

Fig. 3 (Palmerton). Closer view. The incision in the cornea can be seen. Mattress suture has been removed and all is ready to begin to put strain on this corneal incision.

of the incision and the occurrence of a little gush of aqueous.

Results: Part I

Group I consisted of four rabbits, No. 21 through No. 24. They were killed three days after surgery (table 1).

Both eyes in rabbit 22 appeared to be in poor condition. All the rest appeared to be in good condition. The results shown in Table 1 are not felt to show anything significant because of the short time interval between making the incisions and testing.

A deposit of cortisone could be seen subconjunctivally in each left eye at the time of testing.

Sections from the corneas of rabbit 25, an animal treated the same as those in Group I, but not tested, showed no appreciable difference in the microscopic appearance of the wounds of the two eyes.

TABLE 1*

RESULTS: GROUP I

Rabbit No.	Eye	Interval Between Incision and Testing (days)	Gm. (cc.) of Pull to Disrupt Wound
21	Right (control)	3	56.6
	Left (cortisone)	3	40.2
22	Right	3	38.0
	Left	3	32.6
23	Right	3	14.0
	Left	3	27.8
24	Right	3	28.6
	Left	3	38.2

* Note: The results in Tables 1 through 4-B were reviewed in the Department of Biostatistics of the University of Minnesota. Because of the large variations in the differences between the control eyes and treated eyes, and because of the small number of animals used, it was concluded that a statistical analysis would not add to the value of this study.

Group II contained five animals, 31 through 35. The eyes of all these animals looked good at all times after surgery. Subconjunctival cortisone could be seen in all the left eyes until the days these animals were killed and tested. The time interval was five days (table 2).

When the work had gone this far it was felt the results might mean something. Control eyes and treated eyes looked equally good. However the treated eyes simply opened with less pull.

TABLE 2

RESULTS: GROUP II

Rabbit No.	Eye	Interval Between Incision and Testing (days)	Gm. (cc.) of Pull to Disrupt Wound
31	Right (control)	5	58.0
	Left (cortisone)	5	24.0
32	Right	5	30.8
	Left	5	26.4
33	Right	5	22.6
	Left	5	15.2
34	Right	5	28.0
	Left	5	13.8
35	Right	5	26.6
	Left	5	17.0

TABLE 3

RESULTS: GROUP III

Rabbit No.	Eye	Interval Between Incision and Testing (days)	Gm. (cc.) of Pull to Disrupt Wound
27	Right (control)	7	72.0
	Left (cortisone)	7	81.0
28	Right	7	78.6 (fig. 4)
	Left	7	14.8 (fig. 5)
29	Right	7	71.6
	Left	7	34.6
30	Right	7	55.0
	Left	7	23.6
37	Right	7	46.8
	Left	7	29.0
38	Right	7	61.0
	Left	7	44.0

In the above group and in succeeding groups the traction sutures were inserted at the time of testing, as most of the traction sutures if put in at the time of operation were found to have sloughed out by the fifth or sixth postoperative days.

Sections were taken from corneas of eyes treated in the same maner as those in Group II (rabbit 20). The control eye showed a little proliferation of fibroblasts in the margins of the incisions and beginning displacement of the fibrin plug. Sections from the treated eye looked quite similar—possibly there was less proliferation of fibroblasts.

In Group III the animals were killed seven days after making the corneal incisions. In this group were rabbits 27, 28, 29, 30, 37, and 38. In all instances the eyes looked good at the time of testing. It will be seen from Table 3 that with one exception the treated eye was found on testing to be definitely weaker than its fellow (control) eye.

Figure 4 shows a section from the control eye of rabbit 28. Although the bridge is

Fig. 4 (Palmerton). From the right (control) eye of rabbit 28. It shows that, although the bridge is thin, it consists of actively proliferating fibroblasts (×85).

thin it is well filled with proliferating fibroblasts. Figure 5 shows a section from the treated eye of the same animal; there is marked depression of the repair process as compared with the control eye.

Group IV consisted of four animals, 39 through 42, and the experiments ran for 14 days. Rabbits 39 and 40 were treated in the same manner as the animals in Group III as far as the drops were concerned—that is, they received cortisone drops in the left eyes, saline drops in the right eyes, for seven days. Then all drops were stopped for seven more days before the animals were killed and the eyes tested (table 4-A).

The right eye of rabbit 40 appeared well healed but the left eye looked infected and the cornea appeared poorly healed. Figure 6, from the right eye of rabbit 39, shows good healing. Figure 7, from the left eye of the same animal, shows healing if anything more advanced than that of its fellow. This eye received cortisone drops during the first seven days of a 14-day interval. Its response would suggest a quick recovery on the part of the reparative mechanism of the cornea, once the influence of frequent doses of cortisone was stopped.

The other two rabbits, 41 and 42, had cortisone drops in their left eyes all 14 days

Fig. 5 (Palmerton). From the left (cortisone) eye of rabbit 28. It shows a marked depression of the fibroblastic response as compared with that seen in Figure 4 (×85).

TABLE 4-A

RESULTS: GROUP IV-A

TREATED EYES RECEIVED DROPS FIRST SEVEN DAYS ONLY

Rabbit No.	Eye	Interval Between Incision and Testing (days)	Gm. (cc.) of Pull to Disrupt Wound
39	Right (control)	14	121.6 (fig. 6)
	Left (cortisone)	14	145.0 (fig. 7)
40	Right	14	117.0
	Left	14	53.0

TABLE 4-B

RESULTS: GROUP IV-B

TREATED EYES RECEIVED DROPS ALL 14 DAYS

Rabbit No.	Eye	Interval Between Incision and Testing (days)	Gm. (cc.) of Pull to Disrupt Wound
41	Right (control)	14	144.0
	Left (cortisone)	14	93.0 (fig. 8)
42	Right	14	Over 150.0
	Left	14	61.2

prior to testing (table 4-B). At the time of testing the left eye of rabbit 42 looked grossly infected and the cornea appeared poorly healed. The right eye looked good. Both eyes of rabbit 41 looked good.

The treatment of these last two animals differed from that of the rest, in that on the eighth postoperative day the left eyes were each given a subconjunctival injection of about 2.5 mg. of cortisone suspension.

Figure 8, a section from the left eye of rabbit 41, shows a marked depression of the healing process. Grossly this eye looked good all along and the cornea appeared to be healing well.

EXPERIMENTS: PART II

The purpose of the second part of this project was to attempt to show if cortisone was more effective when given subconjunctivally than when given as drops in the conjunctival sac. In making this comparison an attempt was made to let the dosages correspond to those that might be used clinically.

Four young rabbits were used. They were anesthetized, prepared, and operated upon in the same manner as those in Part I, but postoperatively the procedure was different.

Immediately after the surgery each left eye was given a subconjunctival injection of 2.5 mg. of cortisone suspension, and these eyes were seen to have good sized deposits of cortisone under the conjunctivas until four days later, at which time the left eyes were again given subconjunctival injections of cortisone, 2.5 mg. each.

Fig. 6 (Palmerton). From the right eye of rabbit 39, shows good healing (×85).

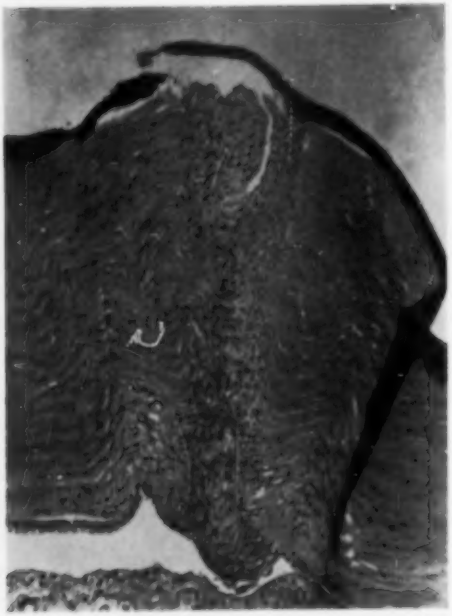


Fig. 7 (Palmerton). From the left eye of rabbit 39, shows healing, if anything, better than that of its fellow. This eye received cortisone drops during the first seven days of a 14-day postoperative interval. This response suggests a quick recovery on the part of the reparative mechanism of the cornea, once the influence of frequent doses of topical cortisone has stopped.

The right eyes were not disturbed until 12 hours after surgery, when a regime of cortisone drops six times a day was begun, the drops containing approximately 8.3 mg. of cortisone per cc., suspended in saline.

The drops in the right eyes were continued for seven days. Then the rabbits were killed and the eyes, both right and left, of all animals were enucleated. Sections of the corneas were made for microscopic study. The tensile strengths of the incisions were not measured. At the time of enucleation each left eye showed what appeared to be a deposit of cortisone subconjunctivally. These areas were not sectioned; they did not have the gross appearance of abscess formation.[10]

Results: Part II

The findings varied from mild to almost complete suppression of repair judging from fibroblastic activity. But it was noted that if the right eye of a given animal showed severe depression, the left eye also showed marked depression of the repair process (figs. 9 and 10). But if, on the other hand, the right eye showed mild inhibition of repair, the left eye of the same animal also showed mild inhibition (figs. 11 and 12).

Comment

The results of this work show that in the rabbit, the cornea is not exempt from the

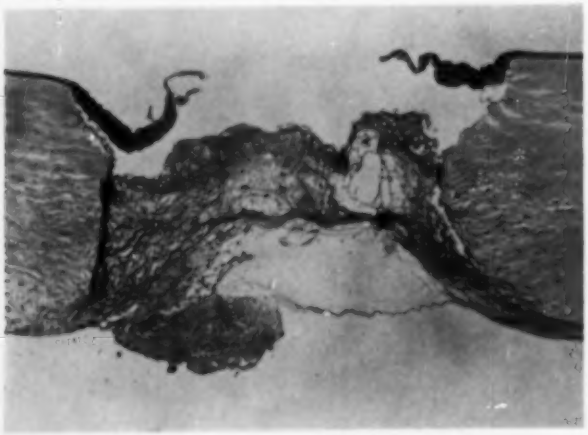


Fig. 8 (Palmerton). From the left eye of rabbit 41, shows a marked depression of the healing process. Grossly, this eye looked quiet and the cornea appeared to be healing well (×85).

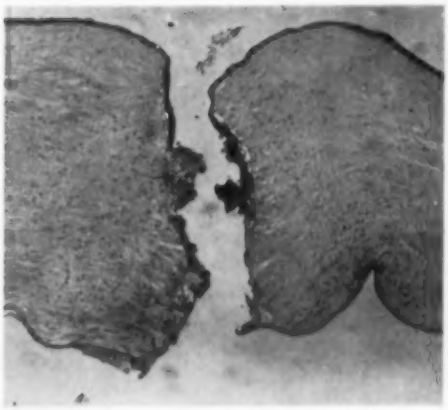


Fig. 9 (Palmerton). Right eye of rabbit 52 (×62).

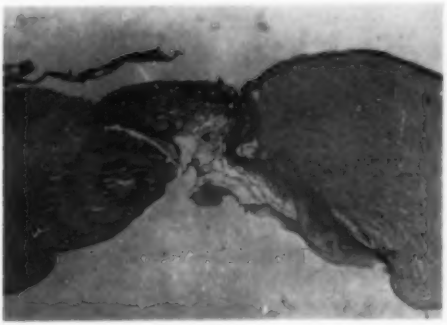


Fig. 10 (Palmerton). Left eye of rabbit 52 (×62).

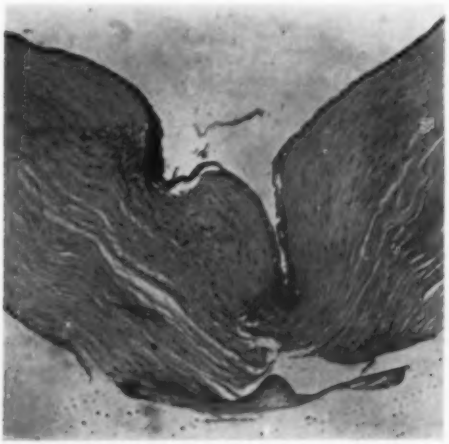


Fig. 11 (Palmerton). Right eye of rabbit 55 (×62).

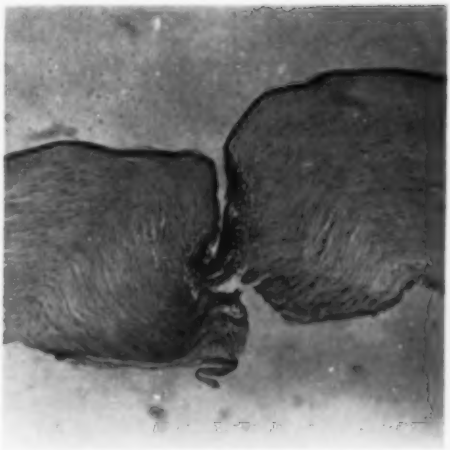


Fig. 12 (Palmerton). Left eye of rabbit 55 (×62).

action of cortisone on mesenchymal tissue in general, in blocking the response to injury, and in inhibiting the healing process. These findings are in agreement with those of other workers. It furthermore seems that there is considerable variation in individual subjects, and this has also been noted by others. Cortisone by the method of drops appears to be as effective as subconjunctival cortisone and this is in agreement with the work of Michaelson.[12] Cortisone drops should not be termed innocuous since six doses daily were able to suspend the healing mechanism in some of the subjects.

Although no special effort was made to show it in this work, it was my impression that the cortisone-treated eyes were not as resistant to infection as the control eyes.

Human eyes may not react like rabbit eyes, but it is felt that eye surgeons should be cautious about the intensive use of this agent before or immediately after cases involving corneal incisions. Bearing in mind the work of Yasuna and his co-workers[19] it would seem probably safer to use systemic doses of cortisone, rather than local dosage, in the immediate postoperative period.

This inhibition of healing seems to be operative before the stage of fibroblastic

proliferation, as treated wounds in these experiments were found to be weaker than the control wounds at the end of five days, when the fibroblastic activity has not yet become a significant factor in normal healing.[13]

Summary

Experimental work is described in detail, which deals with observations on the effects of locally applied cortisone on the healing of incisions made in rabbit corneas. The tensile strengths of partly healed corneal incisions were measured, comparing treated eyes with control eyes. Photomicrographs are presented to show effects of cortisone on corneal healing. Additional work is described in which an attempt was made to show the intensity of the effects of cortisone given as drops versus cortisone given subconjunctivally.

Conclusions

Topically administered cortisone causes definite inhibition of healing of incisions in the corneas of rabbits, as shown by testing the tensile strengths of the incisions, and by microscopic sections. This inhibition ceases promptly when the cortisone is no longer given. Cortisone administered as drops in the conjunctival sac appears to be as effective as when given by the subconjunctival route.

628½ 6th Street.

My sincere thanks to Dr. Erling W. Hansen and Dr. John P. Wendland for their help and encouragement in carrying on this study.

References

1. (a) Sprague, R. G., Power, M. H., Mason, H. L., Albert, A., Mathieson, D. R., Hench, P. S., Kendall, E. C., Slocumb, C. H., and Polley, H. F.: Observations on the physiologic effects of cortisone and ACTH in man. Arch. Int. Med., **85**:199-258, 1950.

(b) Russell, J. A.: Physiology of the pituitary-adrenal system. Bull. New York Acad. Med., **26**:240-250, 1950.

(c) Spain, D. M., Molomut, N., and Haber, A.: Biological studies on cortisone in mice. Science, **112**: 335-337, 1950.

(d) Plotz, C. M., Howes, E. L., Blunt, J. W., Meyer, K., and Ragan, C.: Action of cortisone on mesenchymal tissues. Arch. Dermat. & Syph., **61**:919-921, 1950.

(e) Ragan, C., Howes, E. L., Plotz, C. M., Meyer, K., Blunt, J. W., and Lattes, R. S.: The effect of cortisone and ACTH on connective tissue. Bull. New York Acad. Med., **26**:251-254, 1950.

(f) Baxter, H., Schiller, C., and Whiteside, J. H.: The influence of ACTH on wound healing in man. Plast. and Reconstruct. Surg., **7**:85-99, 1951.

(g) Ragan, C., Howes, E. L., Plotz, C. M., Meyer, K., and Blunt, J. W.: Effect of cortisone on the production of granulation tissue in the rabbit. Proc. Soc. Exper. Biol. & Med., **72**:718-721, 1949.

(h) Creditor, M. C., Bevans, M., Mundy, W. L., and Ragan, C.: Effect of ACTH on wound healing in humans. Proc. Soc. Exper. Biol. & Med., **74**:245-247, 1950.

(i) Findlay, C. W., Jr., and Howes, E. L.: The combined effect of cortisone and partial protein depletion on wound healing. New England J. Med., **246**:597-604, 1952.

(j) Cornman, I.: Selective damage to fibroblasts by desoxycorticosterone in culture of mixed tissues. Science, **113**:37-39, 1951.

(k) Schwartzmann, G., Schneierson, S. S., and Soffer, L. J.: Suppression of the phenomenon of local tissue reactivity by ACTH, cortisone and sodium salicylate. Proc. Soc. Exper. Biol. & Med., **75**:175-178, 1950.

2. Koff, R., Rome, S., Kasper, R., Commons, R. R., Button, R., and Starr, P.: Subconjunctival injection of cortisone in iritis. J.A.M.A., **144**:1259-1260, 1950.

3. (a) Jensen, C. D. F., and Ward, J. F.: Topical cortisone in eye disease. Northwest Med., **50**:36-38, 1951.

(b) Woods, A. C.: Use of corticotropin and cortisone in ophthalmology. Arch. Ophth., **48**:266-269, 1952.

4. Purtscher, E.: Histologische frühuntersuchengen nach intracapsulärer staroperation. Arch. f. Ophth., **144**:669-697, 1942.

5. Vail, D. T., Jr.: On hyphemia after cataract extraction. Tr. Am. Ophth. Soc., **31**:496-527, 1933.

6. Ashton, N., and Cook, C.: Effect of cortisone on healing of corneal wounds. Brit. J. Ophth., **35**:708-717, 1951.

7. Newell, F. W., and Dixon, J. M.: Effect of subconjunctival cortisone upon the immediate union of experimental corneal grafts. Am. J. Ophth., **34**:977-981, 1951.

8. Sheppard, L. B.: Comparative effects of cortisone on rabbit eyes treated by cyclodiathermy and cyclo-electrolysis. Am. J. Ophth., **36**:193-203, 1953.
9. McDonald, P. R., Leopold, I. H., Vogel, A. W., and Mulberger, R. D.: Hydrocortisone (Compound F) in ophthalmology. Arch. Ophth., **49**:400-412, 1953.
10. Yasuna, J. M., Ojers, G. W., Frayer, W. C., and Scheie, H. G.: An experimental study of the effect of cortisone on the eye. Am. J. Ophth., **37**:923-931, 1954.
11. Brown, A. L., and Nantz, F. A.: Corneal healing: adhesive power of aqueous fibrin in the rabbit. Am. J. Ophth., **27**:1220-1224, 1944.
12. Michaelson, I. C.: Comparison of results of cortisone treatment by instillation and by subconjunctival injection. Arch. Ophth., **48**:144-147, 1952.
13. Newell, F. W.: Personal communication.

OPHTHALMOLOGIC CHANGES PRODUCED BY PITUITARY TUMORS*

MAX CHAMLIN, M.D., LEO M. DAVIDOFF, M.D., AND EMANUEL H. FEIRING, M.D.
New York

This study is based on a review of 156 cases of pituitary adenomas and craniopharyngiomas. It is concerned primarily with the ophthalmologic changes produced by these tumors and the demonstration of these changes as a help in their diagnosis. Such symptoms as headache and general neurologic signs and symptoms, as well as X-ray data have not been included in this study, nor will surgical or roentgen treatment be discussed.

The cases were selected on the basis of evidence leading to a diagnosis of a pituitary adenoma or craniopharyngioma. In 71 instances, the nature of the tumor was verified surgically. In some of the others, pneumoencephalography confirmed the presence of a mass rising from the sella turcica. Where there was any reasonable doubt as to the nature of the lesion, the case was not included in this analysis. In order to confine this study to pituitary adenomas and craniopharyngiomas, such chiasmal lesions as chordoma, chronic granuloma, metastatic tumor, tuberculum sellae meningioma, and aneurysm, were all excluded. Only cases of chromophobe adenoma, eosinophilic adenoma, craniopharyngioma, and a basophilic state, were included. It was decided to include both craniopharyngiomas and pituitary tumors, since both are chiasmal lesions and their ophthalmologic signs and symptoms are similar.

Inasmuch as the purpose of this paper is to stimulate the earliest possible diagnosis of such lesions, data presented are always the earliest available in a particular case. Thus, if a patient was examined once or twice and then operated upon, and re-examined a year or so later, the data of the subsequent examination were not recorded—only the very earliest information was utilized. However, some patients came to us in a later stage of disease, so that the first available objective information gave evidence of advanced changes.

Our ophthalmologic examinations included visual field studies, study of the optic discs and central visual acuity. In addition, some of the less common ocular signs were included for the purpose of showing how infrequently they do occur.

Table 1 lists the ocular signs in the order of their frequency, as found in our study:

1. Visual field defects.
2. Atrophy of the optic discs.
3. Loss of central vision.
4. Extraocular muscle palsies.
5. Pupillary changes.
6. Involvement of the trigeminal nerve.
7. Papilledema.
8. Proptosis.
9. Nystagmus.

* From the Ophthalmological and Neurosurgical Divisions of the Albert Einstein College of Medicine of Yeshiva University, New York City.

TABLE 1

OPHTHALMOLOGIC FINDINGS IN 156 CASES OF PITUITARY TUMOR AND CRANIOPHARYNGIOMA

	Chromophobes (109 cases)	Eosinophils (23 cases)	Carcinomas (3 cases)	Basophils (3 cases)	Craniopharyngiomas (18 cases)	Total (156 cases)	Percent 100.0
Field defects (bitemporal hemianopsia)	105	8	3	0	18	134 cases	86.0
Verified by surgery	43	6	3	2	17	71 cases	45.0
Optic atrophy (312 eyes)	134	3	4	0	14	155 eyes	50.0
Loss of central visual acuity, Snellen (312 eyes)	73	6	9	0	12	100 eyes	32.0
Extraocular muscle palsy	7		1			8 cases	5.0
Pupillary changes	1					1 case	0.6
Fifth-nerve involvement	1					1 (?) case	0.6
Papilledema	1				4	5 cases	2.5
Proptosis	1				1	2 cases	1.2
Nystagmus						0 cases	

Incidence of bitemporal hemianopsia in chromophobe adenomas and craniopharyngiomas

Chromophobe adenomas	96%
Craniopharyngiomas	100%
Chromophobes and Craniopharyngiomas	96.8%

1. VISUAL FIELD DEFECTS

As is well known, the most constant and classic type of visual field defect in pituitary tumors is a bitemporal hemianopsia. Of the 156 cases, 134 or 86 percent, showed bitemporal hemianopsia in one form or another.

The eosinophilic adenomas usually produce so classical a picture of acromegaly, that, as a rule, it is not necessary to find visual field defects to confirm the diagnosis. In a good many of the cases of eosinophilic adenomas visual fields may not be affected. Thus, in our series, it will be noted that there were 23 cases of eosinophilic adenomas, and 15 of these 23 cases, or 65 percent, showed normal fields. Thus, the incidence of chiasmal interference causing visual field defects in eosinophilic adenomas is found to be only 35 percent.

In basophilism, or Cushing's syndrome, the clinical picture is quite typical and, as is well known, visual fields are practically never affected. However, as in the cases of acromegaly, the clinical features of the patient with basophilism are so characteristic that diagnosis is quite simple. It is therefore apparent that in eosinophilism and basophilism the clinical diagnosis is easily made without any particular help from the visual fields.

On the other hand, the situation is quite different in the case of chromophobe adenomas and craniopharyngiomas. Thus, it will be noted in Table 1 that there was a total of 109 chromophobe adenomas and 18 craniopharyngiomas, and in each of the craniopharyngiomas a bitemporal hemianopsia was found. In the chromophobe adenomas, on the other hand, bitemporal hemianopsia was found in 105 of the 109 cases, an incidence of 96 percent.

Of the remaining four cases, three showed normal fields, while the fourth showed evidence of a nerve fiber bundle defect due to coincident retrobulbar neuritis. In this case, the history was that of a very sudden onset, characteristic of an acute retrobulbar neuritis. The sella turcica showed definite enlargement and the patient showed other signs of dyspituitarism indicative of a chromo-

phobe adenoma. The field defect was strongly suggestive of retrobulbar neuritis. The pain behind the eye, as well as the complete lack of involvement of the contralateral visual field also suggested a diagnosis of retrobulbar neuritis. Air studies were done and these showed completely normal basal cisterns, indicating that there was no evidence of any mass projecting from the enlarged sella turcica to affect the visual pathways. It was believed, therefore, that this man had an acute retrobulbar neuritis independent of his intrasellar chromophobe adenoma, and his subsequent clinical course confirmed this.

Disclosure of so high an incidence (96 percent), of bitemporal hemianopsia in chromophobe adenomas therefore makes the visual field study a very important factor in the diagnosis of this tumor. If one adds the 18 craniopharyngiomas to this group, the incidence of bitemporal hemianopsia in both types of tumor is 96.8 percent. This frequency of visual field involvement becomes all the more important when one considers that in cases of chromophobe adenoma, as in craniopharyngioma, the rest of the clinical picture is not nearly as frequently diagnostic as it is in eosinophilic adenoma or basophilic adenoma. Indeed, a patient suffering from a chromophobe adenoma or a craniopharyngioma may present very little evidence clinically other than a visual field defect. Therefore, this high incidence of 96 percent becomes a very important factor in establishing the presence of chromophobe adenoma or craniopharyngioma.

Of course, roentgenographic evidence is very helpful in these cases, and a high percentage of them will show some involvement of the sella turcica. It is important to note, however, that we have seen a number of cases of chromophobe adenoma and craniopharyngioma in which the X-ray films of the skull did not show any significant changes in the sella turcica, and pneumoencephalography had to be utilized in order to prove the existence of a mass which had been suggested by the presence of bitemporal hemianopsia.

As for the incidence of bitemporal hemianopsia in craniopharyngiomas, this series showed 100 percent occurrence. Admittedly, this is a very small series on which to base any definite conclusions, and the authors know that the literature certainly does not present bitemporal hemianopsia as a constant finding in craniopharyngiomas. On the other hand, the high incidence in this small series

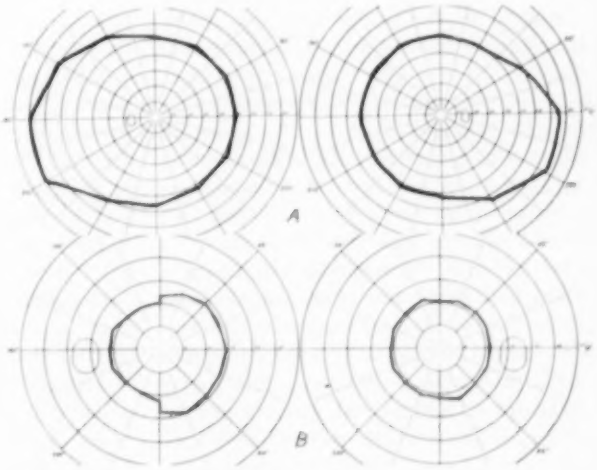


Fig. 1 (Chamlin, Davidoff, and Feiring). A. Z., a 45-year-old white man. Definite clinical and roentgen evidence of chromophobe adenoma. No visual complaints. Vision 20/20 in each eye.

A. Peripheral field for 2/330 white showing no defects.

B. Fields for 1/2000 white showing minimal upper and lower temporal hemianoptic defect in the left field of vision only.

may possibly be due to the sensitive types of minimal testing to which these patients were subjected.

It is pertinent at this point to elaborate somewhat on the characteristics of the bitemporal field defects that we observed. In three of the 103 cases of chromophobe adenoma and in one of the 18 cases of craniopharyngioma with bitemporal hemianopsia, the defects were very minimal ones (Cases 1, 2 and 3). Such small defects could very easily be missed unless minimal types of testing are employed as indicated in the legends to these charts. In nine cases, while bitemporal hemianopsia was present in each of them, there were very marked homonymous hemianoptic features. Four of these were cases of chromophobe adenoma and five were craniopharyngiomas. In other words, the incidence of homonymous characteristics of the defect in craniopharyngiomas was 28 percent, or one out of 3.5, while in chromophobe adenomas, only 3.6 percent, or one out of 27. This has only academic interest and the defects are practically never purely homonymous but show primarily bitemporal features, indicating involvement at the posterior chiasm. The high incidence of bitemporal hemianoptic defect in chromophobe adenomas and craniopharyngiomas makes the detection of early field defects extremely important in this group of cases, where, as pointed out above, the visual symptoms or signs may be the only definite ones and, therefore, the most important in establishing the diagnosis.

While this paper does not primarily concern itself with the detection of early signs of chiasmal interference, some aspects of the phase of the problem merit recapitulation at this time. As pointed out by Chamlin and Davidoff,[1] in almost all cases of chiasmal interference the 1/2000 field is the first to show indication of this defect, and this 1/2000 field usually shows as much defect as does the peripheral field, and often more.

This has been borne out by studies of numerous cases in many of which the peripheral fields remain completely normal while the 1/2000 fields show bitemporal defects (Cases 3 and 4). When the peripheral fields are normal and visual acuity is unaffected, examination of the 1/2000 field becomes especially important, for, without it, the bitemporal defect will be missed.

It is also important to realize that in many of these cases visual acuity is not affected until late, and in such cases, the 1/2000 field again assumes a very important role in making the diagnosis (Case 6). In other words, the 1/2000 field may show evidence of bitemporal defect for many months before central visual acuity, as measured on the Snellen chart, is affected. The patient may merely complain of some slight blurring, but visual acuity, Snellen, remains at 20/20 and the peripheral field for 3/330, or even 2/330 may remain normal.

From the above facts, it is apparent that, particularly when examining a case for chiasmal interference, it is most important that a tangent screen examination be made, preferably at two meters and with a one-mm. test object. Peripheral field studies alone as carried out on the perimeter can very easily miss the evidence of chiasmal interference, and minimal techniques must be used. The vertical meridians must be examined very carefully, especially for the so-called "level differences" and "qualitative differences," by comparing on either side of the vertical line.[2]

While we have found small, white test objects superior to colored ones in these cases, the latter are sometimes useful in evaluating the relative density in defective fields. Thus, in order to corroborate the central defect, it may be found that a 5/2000 red will appear to be somewhat pink or orange on the temporal side of the vertical meridian, and either darker orange or red on the nasal side. However, for exact field studies as to size of field, and so forth, these color studies are not reliable and give varying results from examination to examination. Certainly, for purposes of reduplicable follow-up study, the 1/2000 white is far more reliable and accurate as a baseline.

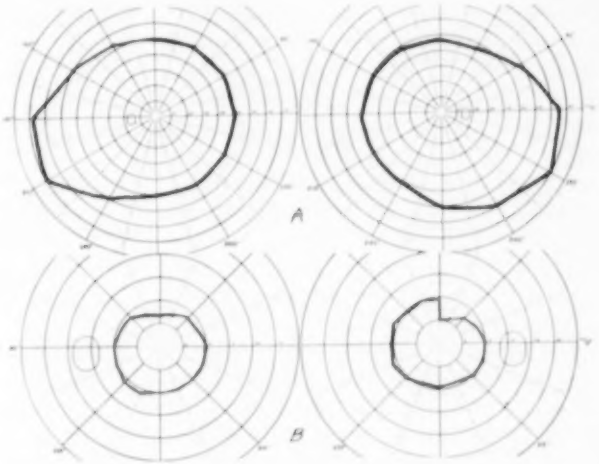


Fig. 2 (Chamlin, Davidoff, and Feiring). A. F., a 17-year-old white youth with craniopharyngioma, verified surgically. No visual complaints. Visual acuity 20/20 in each eye.
A. Peripheral fields for 2/250 white completely normal.
B. Fields for 1/2000 white showing definite upper temporal hemianoptic defect in right eye.

While the 1/330 white peripheral field will undoubtedly show more defect than the 2/330 white in cases of chiasmal interference, we have found that 2/330 white is quite satisfactory if followed by a 1/2000 white, which will usually bring out more than the 1/330 (see Case 4). For routine purposes, therefore, a combination of 2/330 white and 1/2000 white makes an excellent all-inclusive field study for chiasmal interference.

This discussion of the visual field studies in chiasmal interference would not be complete without a word about the differential diagnosis. While it is not within the scope of this paper to go into great detail on this point, we would like to mention particularly one condition which is frequently confused with chiasmal interference, and this is retrobulbar neuritis.

It is unfortunate that in so many cases coming to the neurosurgeon at a rather late date, a diagnosis of retrobulbar neuritis had been accepted until the other eye began to show definite evidence of a temporal defect. In order to avoid such pitfalls, a definite method of diagnosis should be utilized. Thus, before diagnosing retrobulbar neuritis, it is not sufficient merely to find a loss of central vision and some field defect in one eye. One must be very careful that the type of visual field defect found fits into one of the categories found in cases of retrobulbar neuritis,[3] namely, caecocentral scotomas, and/or paracentral scotomas emanating as nerve-fiber bundle defects from the blindspot.

These paracentral scotomas may or may not include fixation, and some of them may extend to the periphery. However in only one instance did we ever find a case of retrobulbar neuritis with visual field defects suggesting hemianoptic characteristics.

In this particular case, the patient was a 43-year-old white woman with a sudden loss of vision in the right eye in June, 1953. The right field showed paracentral nerve fiber bundle defects, and the left field was completely normal. Vision improved spontaneously over a period of several weeks.

In December, 1953, she again experienced a loss of vision in the right eye and was examined by her ophthalmologist who found no light perception in that eye, but on routine testing of the left eye, found visual field defects strongly suggestive of chiasmal interference. (See fields of Case 8.) While the peripheral field showed some hemianoptic features, the central field for 1/2000 white showed that the defective area was not only temporal but upper nasal as well, and without any sharp hemianoptic features. However, with 10/2000 red, there was a suggestion of a hemianoptic feature below. In our experience, the chiasmal area is a rare site

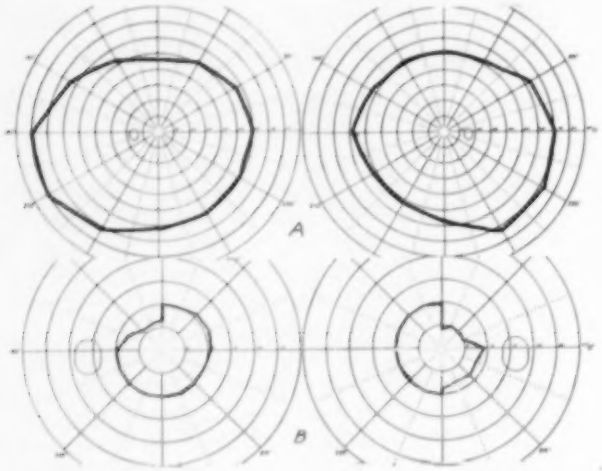


Fig. 3 (Chamlin, Davidoff, and Feiring). W. R., a young white man with craniopharyngioma, verified surgically. Complaint of blurring in right eye only. Vision, right eye, 20/70; left eye, 20/30.

A. Peripheral fields for 2/250 white completely normal.

B. Fields for 1/2000 white showing bitemporal hemianoptic defect.

for retrobulbar neuritis. Pneumoencephalography was performed. The films showed normal cisterns and no evidence of any mass lesion, thus helping to corroborate the diagnosis of retrobulbar neuritis of the right eye, probably in the region of the chiasm, thus affecting the nasal portion of the left optic nerve.

From a practical point of view, if one finds sharp hemianoptic features in a case of so-called "retrobulbar neuritis," it is safest to consider this as chiasmal interference due to a mass lesion until proved otherwise. Therefore, before a diagnosis of retrobulbar neuritis is made, one should plot the visual fields very carefully and find a caecocentral scotoma or nerve fiber bundle defect, types of defects which properly belong to retrobulbar neuritis. The examiner must also be very careful to exclude any hemianoptic features such as may be picked up with 1/2000 white, or even larger test objects.

Even where there is apparently a very large, dense central scotoma, it is advisable to use larger and larger test objects, resorting to hand movements, if necessary, or a very large, red test object, to see if there are any sharp hemianoptic features on either side of the vertical meridian. If any such hemianoptic features are found, one should very carefully consider the possibility of chiasmal interference, and if this possibility is established, one should consider this as due to tumor until proved otherwise, especially since inflammatory lesions of the chiasm are so rare compared to mass lesions.

While central scotomas are mentioned in pituitary tumors, in our experience we have found that so-called "central scotomas" are really part of a central involvement of a hemianoptic defect reaching over from the previously involved "intermediate field." This is pointed out in the article by Chamlin and Davidoff.[1] We have never found a purely central defect with a completely normal intermediate and peripheral field as a part of a pituitary picture. The closest we came to this was the case of F.W.:

F. W. was a young woman with a one-week history of suddenly becoming aware of poor vision in the right eye because she happened to close the left eye. However, even in this case, the contralateral eye did show some temporal defect with 1/2000 white. While this was not very definite at the onset, within a week or 10 days it was, and a chromophobe adenoma affecting particularly the right optic nerve was found on operation.

This isolated finding is in keeping with

a statement by Walsh[4] who claims that he saw only one case of unilateral central scotoma with chiasmal interference, and he admitted that the testing was rather incomplete and that there was evidence of peripheral defect as well.

We will go further and say that, even with such apparent central scotoma there are marked hemianoptic features, unless there should happen to be a very anteriorly placed tumor thus bypassing the chiasmal area and involving primarily the optic nerve as it emerges from the optic canal. Even in such cases, the more peripheral or intermediate portion of the field is usually involved. However, such a situation would be uncommon in pituitary tumors.

This concept of a central scotoma only, without more peripheral or intermediate field defects, occurring in pituitary tumors is rather commonly referred to in the literature. It is important to stress the fact that such a defect is rare, if it occurs at all, in tumors around the chiasm.

Besides analyzing the visual field defect in the affected eye, one should also examine the contralateral eye very carefully. Thus, in retrobulbar neuritis, it is most unlikely that any visual field defect will be found in the other eye.

On the other hand, in almost all cases of visual field defect due to chiasmal interference in one eye, one will find some temporal defect in the contralateral eye, if only in the upper temporal portion of the 1/2000 field. Therefore, a very careful study of the 1/2000 field in the contralateral eye is extremely important in ruling out chiasmal interference when diagnosing retrobulbar neuritis in a single eye or excluding chiasmal interference in that eye (Case 5).

The finding of such a contralateral temporal defect is strongly suggestive of chiasmal interference, and again, at the expense of repetition, once chiasmal interference is diagnosed, this must be considered due to a mass lesion until proved otherwise.

Another important point in the differential diagnosis between retrobulbar neuritis and chiasmal interference due to a tumor is the mode of onset. A reliable history of a sudden onset in retrobulbar neuritis is most important. Cases of so-called "chronic retrobulbar neuritis" with persistent increase in visual field defect over a period of weeks or months suggest the likelihood of an expanding intracranial lesion rather than an inflammatory lesion such as retrobulbar neuritis. In retrobulbar neuritis the maximum visual defect is reached within

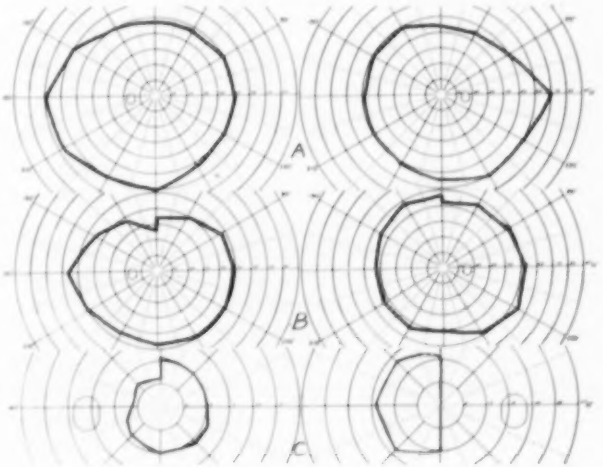


Fig. 4 (Chamlin, Davidoff, and Feiring). R. Z., a 50-year-old white man with clinical evidence of chromophobe adenoma. Complaint of blurring in right eye only. Visual acuity, right eye, 20/200; left eye, 20/40.

A. Peripheral fields for 2/330 white practically normal.

B. Peripheral fields for 1/330 white showing minimal bitemporal upper hemianoptic defects.

C. Fields for 1/2000 white showing complete temporal hemianopsia in the right eye and definite upper temporal hemianoptic defect in the left eye.

a few days, or a week at most. Subsequently, improvement takes place or there is no change. On the other hand if there is further slow progression an intracranial mass lesion should be suspected. In true retrobulbar neuritis, extension of defect is to be found only with a sudden increase, indicating a new attack, and not a slow, insidious increase in defect.

These criteria for differentiating retrobulbar neuritis from a mass lesion at the chiasm are extremely important, and when judiciously applied, will often reward the patient with much faster and more appropriate treatment.

The extremely high incidence of bitemporal defects with chiasmal tumors (in 100 percent of the 18 cases of craniopharyngioma and 96 percent of the 109 cases of chromophobe adenoma) makes it incumbent upon us to interpret the finding of bitemporal hemianopsia as indicative of mass lesions in this area, and, by the same token, the absence of bitemporal defects should lead to a diagnosis of other conditions such as retrobulbar neuritis.

2. Optic atrophy

Optic atrophy, as is well known, eventually appears in those eyes that show bitemporal hemianopsia and thus helps to corroborate the diagnosis. In this particular series, of the 156 cases or a total of 312 eyes, 155 eyes, or 50 percent, showed pallor of the discs indicative of optic atrophy. The number of right eyes and left eyes involved was equal.

The evaluation of pallor merits some discussion. In looking through the records of these 156 cases, it is interesting to note the variety of opinions on the various discs. Thus, in many cases, several observers were quite sure that the appearance of the disc represented optic atrophy, while, on the other hand, equally competent observers thought that the color of these discs appeared to be within normal limits. Aside from pallor, temporally or elsewhere, some types of atrophy appear as decrease in the amount of glial tissue in the physiologic cup, with a prominence of the lamina cribrosa.

In our experience, the color of the disc is not sufficient to diagnose atrophy in many cases. Where there is question, the color must be interpreted on the basis of visual function as brought out by visual field studies. Thus, if visual field studies show that there is a defect, one should consider this pallor as of a pathologic nature, while if the visual field studies indicate no defect whatever, the pallor of the optic nerve head may be regarded as physiologic.

One need not dwell further on the difficulties involved in evaluating the presence or absence of optic atrophy and its differentiation from physiologic pallor merely from the appearance of the discs. This point is brought up only to stress the value of visual field studies in evaluating the color of optic discs.

In many cases of even very severe loss of visual field, especially in those cases which were of only short duration, as with rapid growth of a pituitary tumor, there was no optic atrophy whatever, and this is well known. Thus, a patient may show a very severe temporal hemianopsia in one eye, with encroachment on central vision, and the disc in that eye may appear perfectly normal for many weeks or perhaps even months. Therefore, to rely on the presence or absence of optic atrophy as an indication of pituitary tumor could be most unwise unless the atrophy is quite marked. At best, it is only a corroborative finding after the visual field examination has been made.

On the other hand the presence or absence of optic atrophy in cases of pituitary tumors could be of more than academic importance, and at times may have a good deal of diagnostic value. Thus, in a case with a history which is rather vague as to duration, the presence of a marked degree of atrophy

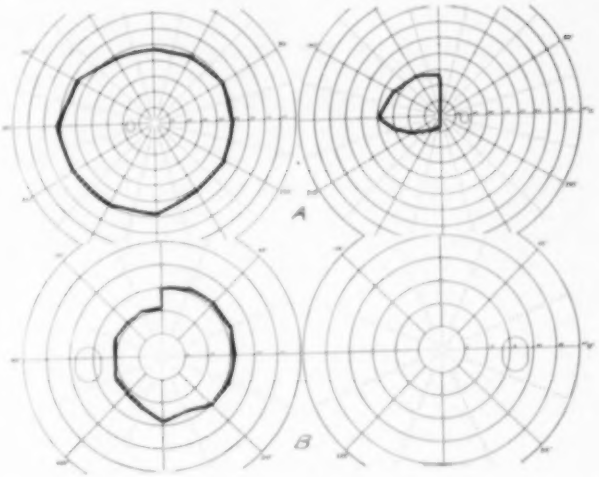


Fig. 5 (Chamlin, Davidoff, and Feiring). A. S., a 56-year-old white woman with clinical evidence of chromophobe adenoma. Visual acuity, right eye, 11/200; left eye, 15/20.

A. Peripheral fields, right eye, 3/250 white; left eye, 2/250 white. While the upper nasal quadrant is shown as spared in this peripheral field, there was some question as to the sharp midline hemianoptic feature. The left peripheral field, while somewhat contracted in the temporal portion, could not definitely be labeled as a temporal defect, and showed no hemianoptic features.

B. Central fields for 1/2000 white. Right eye, 1/2000 white not visualized. Left eye, temporal defect with sharp left upper hemianoptic feature. This sharp upper temporal hemianoptic feature is significantly diagnostic of involvement of the nasal fibers of the left optic nerve, thus indicating that the interference with the right optic nerve is somewhere near the region of the chiasm. Actually, in examining the right central field, while 1/2000 white was not visualized, larger red test objects brought out some hemianoptic features but were difficult to evaluate quantitatively.

would indicate a long-standing process, and the likelihood of relatively less improvement after X-ray or surgical treatment. However, the presence of good color of a disc with profound loss of vision in that eye is likely to indicate a much shorter duration of the disease and therefore a much better prognosis for recovery after treatment.

An additional point may be made as regards optic atrophy, as well as the differential diagnosis between pituitary tumor and retrobulbar neuritis. If there is some question as to whether or not the loss of vision is due to a pituitary tumor or retrobulbar neuritis, the lack of optic atrophy after six or eight weeks of loss of vision is an important point against retrobulbar neuritis and in favor of a pituitary tumor.

In other words, if a patient has an acute attack of retrobulbar neuritis and loses vision from this attack, it is quite likely that with persistence of visual loss there will be a good deal of optic atrophy within four to six weeks. However, when such a loss occurs as a result of pressure of a mass lesion around chiasm, optic atrophy may not appear for many months.

As to the type of atrophy, it is well known that the so-called "primary" type of optic atrophy, or descending type of degeneration, is found with mass lesions. The finding of very definite secondary characteristics, such as filling in of the cup with fibrous tissue, irregular markings around the disc margin and perivascular striping, is indicative of a postinflammatory state of the optic nerve, and would therefore be a point against the atrophy being due to a mass lesion. However, in many cases it is rather difficult to base one's conclusion of primary or secondary optic atrophy on the appearance of the disc alone. At best, the finding of definite atrophy is merely a confirmatory sign of visual loss and an indication of the duration of such loss. Certainly, the lack of atrophy, as can well be understood from what has been said, does not rule out any chiasmal pressure, inasmuch as severe visual field defects may be found before optic atrophy develops.

3. Visual acuity

This criterion was a difficult one to utilize, inasmuch as the standard as to what constitutes normal visual acuity or whether or not a loss of visual acuity has really occurred may become a difficult problem. One must remember that in many cases the patient may never have had 20/20 vision. Perhaps his best vision was 20/30 or 20/40. Many times these patients are not able to furnish a history to clarify this point.

Actually, we took as an indication of visual loss a very definite drop, such as from a known 20/20 to 20/40 or less, or a reliable statement from the patient that his vision was definitely failing. One can see that these are rather loose criteria.

We found that of the total of 312 eyes, 101 of them, or 32 percent, showed some loss of visual acuity by these criteria. Of these, there were slightly more right eyes involved. If there was an acuity of 20/40 or less, or the patient's complaints are taken as evidence of visual failure, only 32 percent in this series showed such loss. On the other hand, we have shown that in 96 percent of these cases there was loss of visual field, which, as pointed out by us in a previous paper,[1] precedes by far the loss of central visual acuity.

As a matter of fact, the "intermediate" or central field may continue to show the bitemporal defect for many months with profound encroachment on the temporal fields, during which time the patient may still continue to retain visual acuity of 20/20 in each eye (Case 6). Thus, in these cases, while there is severe bitemporal or homonymous defect as measured with the 1/2000 field, the patient may not be particularly aware of any visual disturbance. Therefore, if one is to depend on the patient's complaint of loss of central vision (Snellen), or even a demonstrable failure of such vision, recognition of interference with the visual pathways due to a pituitary tumor will be delayed. Again, we are led to conclude that the visual field study is far more important than the visual acuity as measured on the Snellen chart.

The measurement of visual acuity deserves a word of caution. Naturally, when recording visual acuity, refractive errors must be corrected. Therefore, proper refraction must be carried out in all these cases, even in patients who have glasses, in order to be sure that these glasses provide the best possible correction. Where visual acuity is reduced to a level below the normal, the patient must not be hurried while being tested. Thus, if a patient reads 20/50 or 20/60 with ease, it may be possible for him to read a line or so more, if he takes a little time and learns to project the letters in the best portion of his remaining field of vision. This point is particularly important when following a patient that is receiving radiotherapy or that has been operated on, and in which visual acuity is utilized as one of the criteria of progress.

Mention must also be made of the examination of the field by gross finger testing or light perception and projection. In cases in which visual function has become so poor that more accurate testing cannot be employed, one may have to resort to testing light perception.

In such cases, it is often desirable to determine whether light perception is limited to any particular portion of the field. For example, if the appreciation of light is limited to the nasal field or upper nasal quadrant, that finding may well indicate a late state of chiasmal interference. In making such tests, we have found that it is misleading merely to direct a focused light into the eye because the dispersion through the the cornea and lens, as well as the reflection from the adjacent side of the nose or lid edges, may result in a misleading interpretation. For these reasons, in testing light projection, we use a large flashlight with a lens of about 60 cm. in diameter held in the desired field so that the entire light is within the field of vision but the beam is not directed to the eye but rather away from it. Another solution to this problem would be

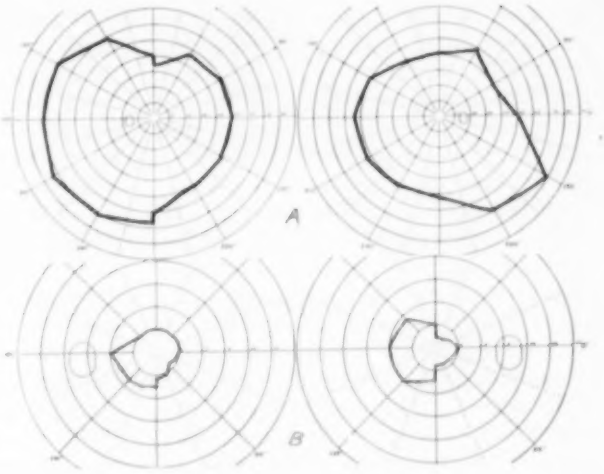


Fig. 6 (Chamlin, Davidoff, and Feiring). Chromophobe adenoma in a 46-year-old white man with complaints of headache and accidental discovery of roentgen evidence of chromophobe adenoma during routine examination for so-called "sinus disease." No visual complaints. Vision in each eye 20/20.

A. Peripheral field for 2/250 white showing upper temporal defect in right eye and nasal hemianoptic defect in left eye, thus indicating a tendency toward right homonymous defect.

B. Field for 1/2000 white showing a more definite right homonymous hemianoptic defect, as well as a left upper temporal hemianoptic defect, thus obliterating the hemianoptic feature in the upper portion of the left field of vision. In this case the field defect is encroaching dangerously upon fixation but the patient has no visual symptoms because the central area is still spared. Such severe encroachment on central field may go on for many months before the patient is aware of any visual defect, especially when central visual acuity (Snellen) is unaffected.

the use of ground glass or translucent material in front of the glass so as to do away with any focused beam and merely provide an illuminated disc.

4. Extraocular muscles

Until relatively recently, involvement of extraocular muscles by pituitary tumors was considered as not very common. In 1872, Bartholow first called attention to the ocular motor and trigeminal disturbances found with lesions about the cavernous sinus.[5] The name, "Jacod's triad,"[6] is applied to the picture of total involvement of the visual pathways and trigeminal neuralgia. This syndrome may be associated with proptosis.

The extraocular muscle involvement in lesions of the pituitary gland is usually due to extrasellar extensions involving the cavernous sinus. In a review of 93 cases of pituitary tumor, Davidoff and Feiring[7] found ocular palsies in eight of the cases. Ptosis was observed in two of these. Excluding the two cases of ptosis, the incidence of extraocular muscle palsies amounted to a little over eight percent. Bardram[8] also reported eight cases showing extraocular muscle palsy in a series of 90 cases of pituitary adenoma, a percentage similar to that of Davidoff and Feiring.

In 1940, Weinberger, Adler and Grant[9] reviewed 169 verified adenomas of the pituitary gland and found involvement of the cavernous sinus in 14 of them. They further stated that these 14 by no means represented the total incidence of palsies of cranial nerves. In discussing the paper, German remarked that he had found 24 instances of extraocular muscular palsy in 50 consecutive cases in Cushing's series of pituitary tumors. This incidence is rather high in comparison with other series. Walsh,[10] reporting on 50 consecutive cases of pituitary tumor, reported only five instances of muscle palsy and two of convergence weakness.

In our series of 156 cases of pituitary tumors and craniopharyngiomas there were eight cases of extraocular muscle palsies, or an incidence of five percent. However, all of these palsies occurred in cases of chromophobe adenomas and none in the craniopharyngiomas. Therefore, in order to make a more suitable comparison with the other

series which included adenomas only, the incidence in our series was eight cases out of 109, or an incidence of 7.3 percent. This is similar to the series reported by Davidoff and Feiring, as well as Bardram, but lower than that of Walsh and certainly lower than that of German.

Of the eight cases of muscle palsy, two showed involvement of the third, fourth, and sixth nerves in one eye, and two showed involvement of only the third nerve in one eye. Of the remaining four cases, all of them showed lateral rectus palsy, one of them showing it in both eyes. Two of these cases showed medial rectus palsy in addition. Ptosis was present in both cases, showing complete palsy of the third, fourth, and sixth nerves, as it was in one of the other cases showing third-nerve involvement.

In three of our cases, the patients complained of diplopia although there was no evidence of any muscle palsy. In all three cases, the onset of diplopia occurred simultaneously with loss of central vision in one eye, with some turning in or out of the poor eye and resulting diplopia in the noncorresponding portions of the paracentral areas of the retinas.

In one of our cases (B. M.), the patient began to complain of double vision when he started to lose central vision in one eye. With more profound loss of central vision, the symptoms disappeared, for obvious reasons. Later on, following successful surgery and a marked improvement of vision, he again began to complain of double vision as visual acuity improved in the defective eye.

It is our impression that the double vision in these cases comes about in the following manner:

Due to the loss of central vision, fixation is poor in the affected eye and the eye turns out slightly, although in some cases it may turn in, instead. Therefore, since the eyes are not in visual alignment for a particular object in the field of vision, the image of that object will fall on noncorresponding points in the paracentral area of the retina in each eye, thereby causing double vision.

Similar observations were made by Bardram in the paper already mentioned. He found such symptoms in 15 out of 90 patients who complained of diplopia without any demonstrable extraocular muscle palsy. He also attributed this diplopia to defective fixation due to poor central vision.

In 1949, Walsh reported on two cases of bilateral total ophthalmoplegia with adenoma of the pituitary gland.[19] Ocular palsies may be observed in pituitary tumors in which extensive necrosis and/or hemorrhage has occurred, and this is known as "pituitary apoplexy." One case in our series fits into this category.

This was a 50-year-old man with a history of rapidly developing diplopia over a period of several days. Examination revealed total external and internal ophthalmoplegia of the right eye and fields that were normal to confrontation. The patient was too uncomfortable for detailed field study. Over a period of 12 days his headache subsided and he became more fit for field study. At that time, vision was found to be reduced to 5/200 in each eye and a bitemporal hemianopsia was found (Case 7). Craniotomy was performed and a large cystic tumor filled with blood was found arising from the pituitary gland. Evacuation led to rapid recovery in visual acuity and fields, as well as almost complete disappearance of the muscle palsy. This case was considered as one of so-called "pituitary apoplexy."

5. Pupillary changes

Of the 156 cases, we found pupillary abnormality that seemed to be worthy of note in only one case. This was in the case of G. T.

In this particular patient, the pupils were small and almost pinpoint in size, slightly irregular and fixed to light, but they did react to accommodation. Spinal fluid examination failed to reveal any evidence of lues, and pneumoencephalography showed the presence of a chiasmal tumor mass. The remainder of the clinical history was compati-

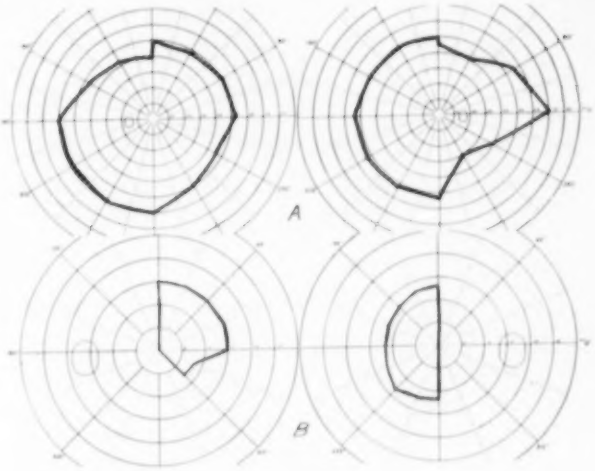


Fig. 7-A and B (Chamlin, Davidoff, and Feiring). Case of so-called "pituitary apoplexy."

A. Preoperative peripheral fields for 2/250 white, showing bitemporal hemianoptic defects. Vision, right eye, 6/200; left eye, 20/200.

B. Preoperative central fields for 1/2000 white showing bitemporal hemianopsia with involvement of left lower nasal field.

ble with that of a chromophobe adenoma. She had a typical bitemporal hemianoptic defect. After receiving a considerable amount of radiation therapy there was a good deal of improvement, both in visual fields and acuity, and the pupils increased in size and reacted well to light and accommodation. This type of pupillary finding has been described by Lefever as an Argyll Robertson type of syndrome occurring with pituitary tumors.[11]

Aside from this case, the only other pupillary changes of note were in patients who had lost sufficient visual acuity to cause widened, dilated pupils which did not react well to light. Thus, in eyes which showed a good deal of atrophy or a good deal of loss of central field, the pupil did not react to light. This was undoubtedly a direct effect of the loss of macular function and did not have any special significance. Therefore, it may be concluded that changes in the pupil, outside of the one bizarre case described above, are not significant in cases of pituitary tumor except insofar as they do not react to light directly as a result of loss of central vision.

6. Involvement of the Trigeminal Nerve

The incidence of trigeminal nerve involvement as shown by loss of corneal sensation was found in only one out of the 50 cases mentioned by Walsh above. In our series of 156 cases, in only one case (L. B.), was there some diminution of fifth nerve sensation. Retention of sensation in the first and second branches of the fifth nerve is rather difficult to explain in cases in which the third, fourth, and sixth nerves are involved. Walsh has also commented on this point. Lack of involvement of the trigeminal nerve is rather difficult to explain, if one is to assume that the paralysis of the third, fourth, and sixth nerves is due to pressure within the cavernous sinus. Several patients did complain of pain in the face, although none of them showed any definite loss of sensation over the areas indicated.

7. Papilledema

Papilledema is characteristically absent in cases of pituitary tumor. It may be said that when papilledema does occur as an early sign, it is most unlikely that one is dealing with a pituitary tumor. As a matter of fact, it is usually in the very late stages with marked intracerebral extension, that papilledema may supervene, and even then it may be difficult to recognize in view of the preexisting optic atrophy. In our three cases of carcinoma of the pituitary gland, papilledema was not seen, even at a very advanced stage of the disease.

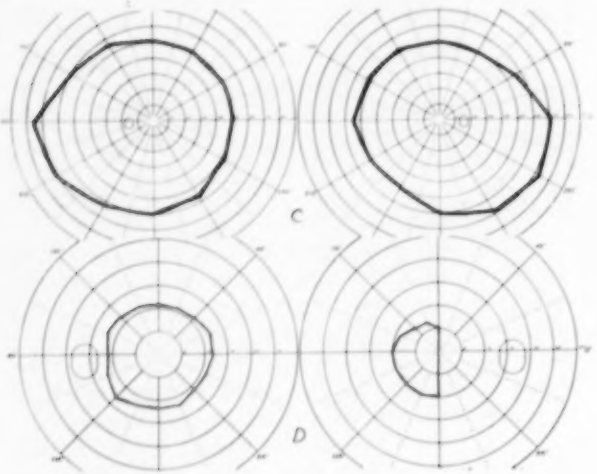


Fig. 7-C and D (Chamlin, Davidoff, and Feiring). Same case as shown in Figure 7-A and B.

C. Postoperative peripheral fields for 2/250 white. Vision, right eye, 20/100, left eye, 20/20. Peripheral fields practically normal.

D. Postoperative fields for 1/2000 white. Left eye practically normal. Right eye showing residual hemianoptic defect.

In cases of craniopharyngioma, while papilledema is more frequently found, it is again not a common finding, although perhaps more common in children than in adults. While in some of our cases which went on to a fatal termination papilledema did set in toward the end of the disease (this was particularly true in the cases of craniopharyngioma), we found only one case (L. B.), of a chromophobe adenoma in which papilledema was seen at the onset, and this was an unusual case in many other respects. In three cases of craniopharyngioma (D. K., J. R. and E. T.), papilledema was seen early in the course of the disease.

In the cases of acromegaly, while many times the discs seemed quite hyperemic, it could not be said that true papilledema was present at any time. In a review of 100 cases of acromegaly, Davidoff and Cushing found papilledema had occurred in three percent of these cases. Our findings would indicate a total of four out of 156 cases as having shown papilledema early in our observations. This is a total of 2.5 percent. It may thus be said that papilledema does occur in cases of craniopharyngioma but it is quite rare in cases of chromophobe adenomas, and its presence should militate against diagnosis of pituitary adenoma in general.

8. Proptosis

Proptosis was present in three out of 169 cases studied by Weinberger, et al.[9] Walsh[10] described two such cases with pituitary tumors. Other authors mention it in conjunction with involvement of the cavernous sinus.

In our series, two cases showed a true proptosis, E. R., a 14-year-old girl with a chromophobe adenoma, and A. M., a 12-year-old girl with a craniopharyngioma. Neither of these two cases showed any extraocular muscle palsy or any other sign of cavernous sinus involvement.

9. Nystagmus

Not a single instance of nystagmus was found in the 156 cases studied. Walsh[10] reported two cases of nystagmoid movements in his study, while other observers do not even mention it.

Summary

1. Of a total of 156 cases of pituitary tumors and craniopharyngiomas, visual field defects were found in 134 or 85 percent of the cases. None of these occurred in basophilic tumors. Furthermore, in eosinophilic tumors as well as basophilic tumors, the

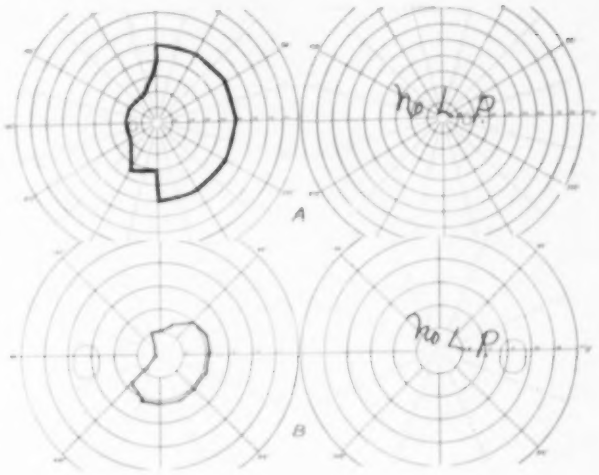


Fig. 8 (Chamlin, Davidoff, and Feiring). A case of retrobulbar neuritis, in M. E., a 43-year-old white woman, who is not included in the series of 156 cases, which were all tumors. Second attack of retrobulbar neuritis in the right eye. Vision, right eye, no light perception; left eye, 20/40.

A. Peripheral field in left eye for 2/330 white, showing temporal defect with some hemianoptic features.

B. Central field for 1/2000 white showing temporal defect, but not sharply hemianoptic and reaching over to involve the upper nasal area. This lack of sharp hemianoptic feature for 1/2000 white in inflammatory lesions has been noted by us once before in a case that was probably optochiasmal arachnoiditis.

clinical picture is quite characteristic, and visual field studies are not essential for corroboration of the diagnosis. Visual field defects are not found, as a rule, in basophilism. Bitemporal hemianopsia was found in 35 percent of the cases of eosinophilic adenoma; 105 out of 109 cases of chromophobe adenoma (96 percent) showed bitemporal hemianopsia. In all 18 cases of craniopharyngioma, there was evidence of bitemporal hemianopsia.

2. Optic atrophy was found in 50 percent of our cases.

3. Loss of central visual acuity (Snellen) was observed in 32 percent.

4. Diplopia due to extraocular muscle palsy was noted in five percent.

5. Pupillary changes other than those due to visual loss or ocular motor-nerve palsy were found in one case (less than one percent).

6. Involvement of the fifth cranial nerve was found in one case and that was of a rather dubious nature.

7. Papilledema was present in four cases out of a total of 156. Three of these occurred in craniopharyngioma and the fourth one in an atypical case of chromophobe adenoma. Thus, the total incidence was only 2.6 percent.

8. Proptosis was observed in only two cases.

9. Nystagmus was not observed in this series.

Conclusions

The three most frequent ophthalmologic changes found in pituitary tumors and craniopharyngiomas are visual field defects (some form of bitemporal and hemianopsia), optic atrophy, and loss of central visual acuity. Since optic atrophy and loss of central visual acuity are dependent upon and shown in the field defect, and since 96 percent of the cases of pituitary tumor and craniopharyngioma show such defect, the visual field examination may be said to be the most important single ophthalmologic criterion for evidence of such tumors.

1710 Newport Avenue,
Bronx 61, New York.

References

1. Chamlin, M., and Davidoff, L. M.: The 1/2000 field in chiasmal interference. Arch. Ophth., **44**:53 (July) 1950.

2. Chamlin, M.: Minimal defects in visual field studies. Arch. Ophth., **42**:126 (Aug.) 1949.

3. ———: Visual field changes in optic neuritis. Arch. Ophth., **50**:699 (Dec.) 1953.
4. Walsh, F. B.: Clinical Neuro-Ophthalmology. Baltimore, Williams & Wilkins, 1947, p. 380.
5. Bartholow, R.: Aneurysms of arteries at the base of the brain: Their symptomatology, diagnosis, and treatment. Am. J. M. Sci., **44**:373, 1872.
6. Jacod: Cong. Soc. franç d'oto-rhino-laryng., 1914.
7. Davidoff, L. M., and Feiring, E. H.: Surgical treatment of tumors of the pituitary body. Am. J. Surg., **75**:99, 1948.
8. Bardram, M. T.: Oculomotor paresis and nonparetic diplopia in pituitary adenomas. Acta Ophth., **27**:225, 1949.
9. Weinberger, L. M., Adler, F. H., and Grant, F. C.: Primary pituitary adenoma and the syndrome of the cavernous sinus: A clinical and anatomic study. Arch. Ophth., **24**:1197 (Dec.) 1940.
10. Walsh, F. B.: Bilateral total ophthalmoplegia with adenoma of the pituitary gland. Arch. Ophth., **42**:646, 1949.
11. Le Fever, C. W.: Argyll Robertson syndrome occurring with pituitary tumors: Report of two cases. Am. J. Ophth., **18**:442 (May) 1935.

THE CELLS AND NERVES OF THE HUMAN CORNEA*

A STUDY WITH SILVER CARBONATE

K. SCHARENBERG, M.D.
Ann Arbor, Michigan

The histology of the cornea has been investigated for more than 90 years, but many of the problems are still far from solved. A particularly controversial question is the relationship between the fixed elements of the cornea and the nerves. The reason for this is the complicated histologic structure of cells and nerves which could not be analyzed satisfactorily by the older methods. The histologic requirements are met by the silver carbonate technique of del Rio Hortega, and the main objective of the present contribution is to demonstrate the morphology of the cell-nerve synapse in the human cornea.

The silver-carbonate method was previously used by Prieto Diaz[1] and recently by Sverdlick[2] for the investigation of the cells of the cornea but not its nerves.

With low magnification the cells appear as irregularly shaped, interconnected bodies which form a syncytium with wide meshes (fig. 1). With higher magnification they are star-shaped, triangular, or quite irregular (figs. 1, 2, and 3); elongated cells with a very long and thin nucleus (fig. 3), and

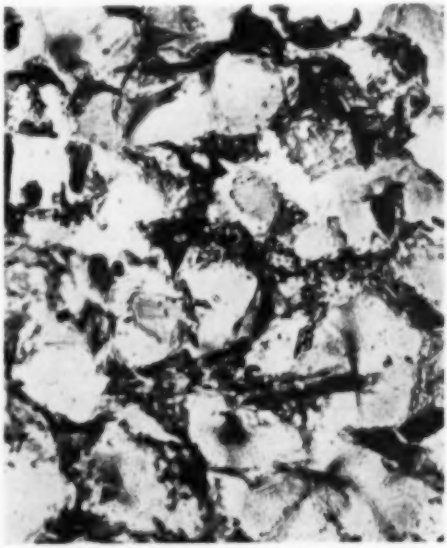


Fig. 1 (Scharenberg). Fixed elements of the cornea, irregular in shape, which form a syncytium with wide meshes. (Photomicrograph ×100.)

* From the Laboratory of Neuropathology and Neuro-ophthalmology, The Neuropsychiatric Institute, University of Michigan. Read in part before the XVII International Congress of Ophthmology, September 14, 1954, New York, New York. This study was supported by a Grant-in-Aid from the United States Department of Public Health and Welfare.

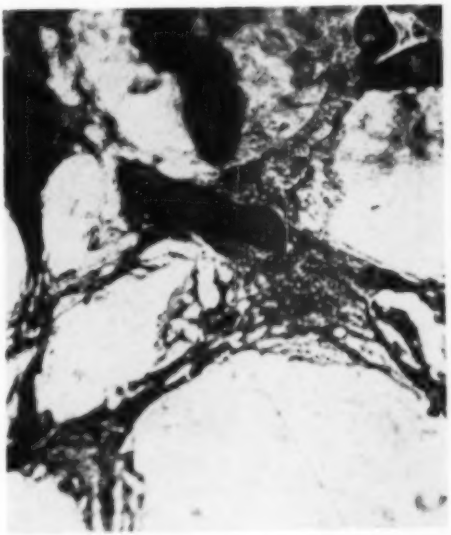


Fig. 2 (Scharenberg). Approximately star-shaped cells interconnected by plasmatic bridges; the cytoplasm has a lacelike structure with numerous vacuoles; the nucleus is oval shaped and is eccentric. (Photomicrograph ×400.)

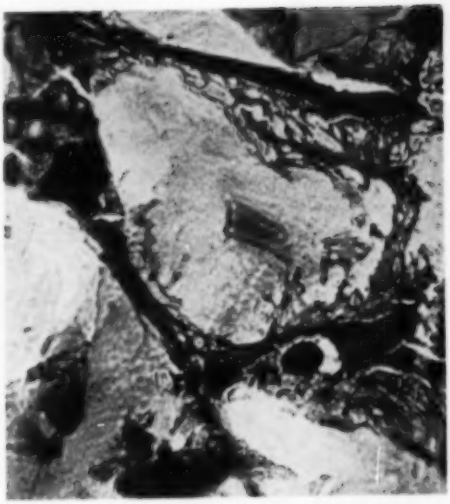


Fig. 3 (Scharenberg). Elongated cells of the cornea with long and thin nuclei. Near the nucleus (lower part of the illustration) there is a leukocyte. (Photomicrograph ×400.)

elements with filamentlike processes are common (fig. 4). Numerous plasmatic bridges interconnect the cells which, as mentioned, form a syncytium or a plexus the meshes of which are filled with slightly granular material (figs. 1, 2, and 3). These elements have an elaborate histologic structure: the nucleus is large, oval, round, or elongated, contains small, round nucleoli, and is frequently eccentric (figs. 2, 3, and 4). The cytoplasm forms a lacelike network with numerous vacuoles which are small near the nucleus and larger at the periphery (figs. 2, and 3).

The cornea is separated from the epithelium by Bowman's membrane which is considered a structureless sheet of uniform thickness beneath the epithelium, from which it is sharply defined (Friedenwald, 1952[2]). This description is based on cross sections prepared with conventional methods. In silver-carbonate preparations cut horizontally the histologic structure of this membrane is different: it is not homogeneous but contains shadowy polymorph elements which are connected with the fixed cells of the cornea and with those of the epithelium (fig. 5). The latter is usually described as stratified squamous epithelium of several layers,

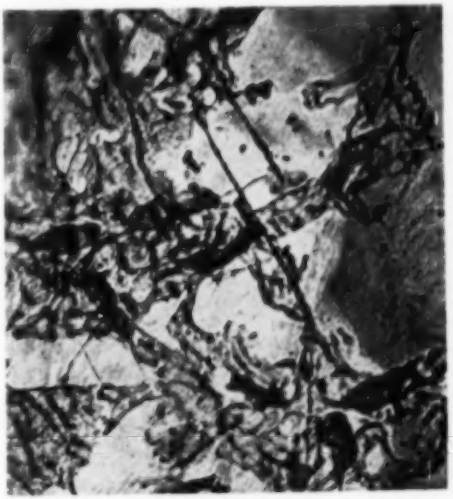


Fig. 4 (Scharenberg). Fixed cells of the cornea with very long filamentlike processes. (Photomicrograph ×400.)

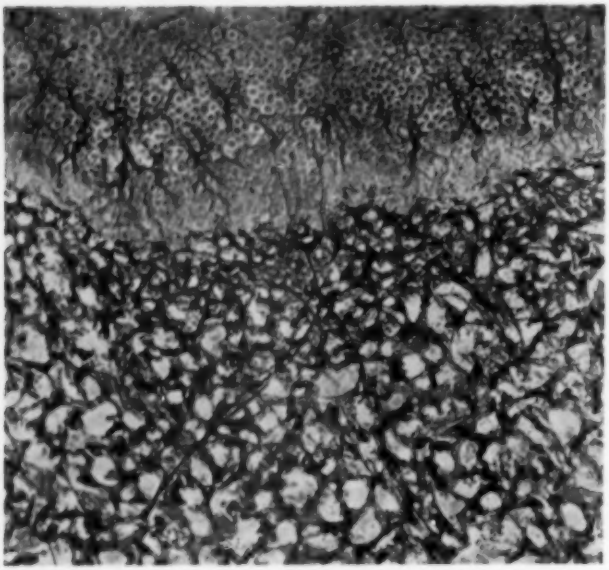


Fig. 5 (Scharenberg). Horizontal section through the cornea, Bowman's membrane, and epithelium. The membrane is fairly sharply demarcated from the cornea and contains numerous interconnected polymorph elements which are connected with the fixed cells of the cornea and penetrate the epithelium. A bifurcated nerve of the cornea penetrates Bowman's membrane and the epithelium. (Photomicrograph ×100.)

the basal cells of which rest upon Bowman's membrane.

Silver-carbonate preparations also demonstrate this arrangement, but in addition show the above-mentioned interconnected polymorph elements which penetrate the epithelium and frequently surround the squamous cells (figs. 5, and 6). It will be demonstrated later that the polymorph cells are intimately connected with the nerves.

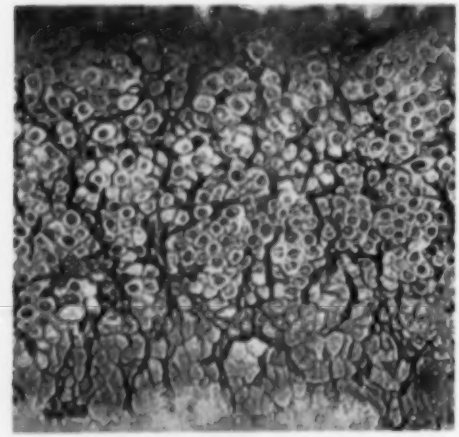


Fig. 6 (Scharenberg). Horizontal section through the epithelium which shows numerous interconnected polymorph cells between the columnar epithelial elements. (Photomicrograph ×400.)

Among the structures of the cornea there are numerous fibers which are for the most part delicate and are usually straight but may also be coarse and arched; they cross at various angles, some at 90 degrees, others obliquely, forming an irregular network (figs. 7, and 8). These structures arise from the connective tissue bundles of the sclera and are more numerous at the corneal-scleral junction. They are not connected with the elements of the cornea which they traverse without regard to the pattern of its cells and nerves.

The nerves of the cornea

There are four problems to be considered: (1) The morphology of the nerve bundles, (2) the relationship of the nerves to the fixed cells of the cornea, (3) the structure of the synapse, and (4) the structure of the nerve end-organs.

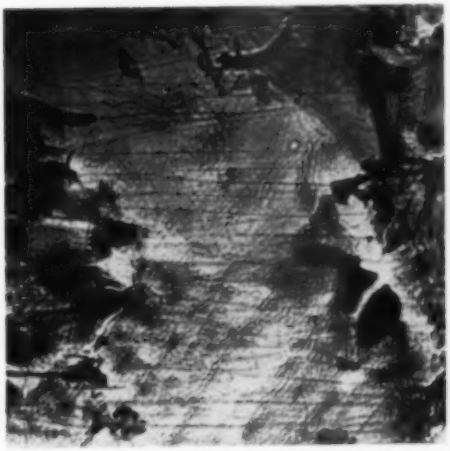


Fig. 7 (Scharenberg). Delicate straight fibers of the cornea which cross at various angles. (Photomicrograph ×500.)

1. Morphology of the nerve bundles

There are numerous coarse nerve bundles of four types:

a. Bundles of coarse fibers intermixed with large elongated nuclei of the elements of Schwann; the latter are more numerous in the triangular areas of bifurcation and are arranged parallel to the nerve fibers (fig. 9). Many of the coarse fibers within the bundles do not cross but enter one or the other of the bifurcated branches; some cross to the opposite branch, others divide and enter both branches. An occasional thin, straight, aberrant fiber leaves the main nerve stem, crosses the area of bifurcation, and is lost among the fixed cells (fig. 9).

b. A different nerve bundle is shown in Figure 10; here a very coarse myelinated nerve enters the left branch undivided, while several thinner fibers cross to the opposite branch.

c. Branched bundles which contain in the left branch a complicated network of plasmatic structures interwoven with numerous nerves, and in the right branch only coarse fibers (fig. 11).

d. Delicate bundles with less complicated structures which contain only a few nerve fibers in the left branch, a very delicate network in the triangular area, and a few thin

Fig. 8 (Scharenberg). Coarse straight and arched fibers of the cornea; because of their appearance these fibers were frequently considered to be elastic. (Photomicrograph ×500.)

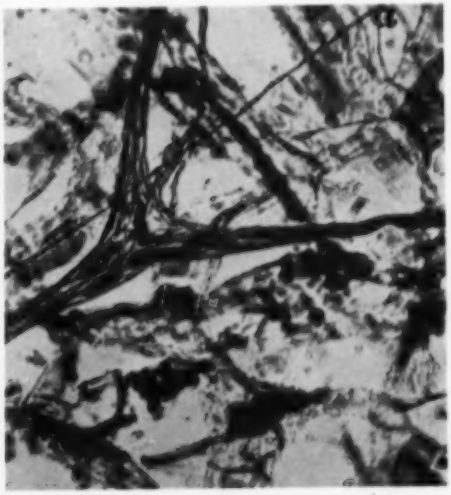


Fig. 9 (Scharenberg). Coarse nerve bundles with fibers surrounded by delicate plasmatic structures and large, elongated nuclei of the elements of Schwann—with the straight aberrant fiber (a). (Photomicrograph ×400.)

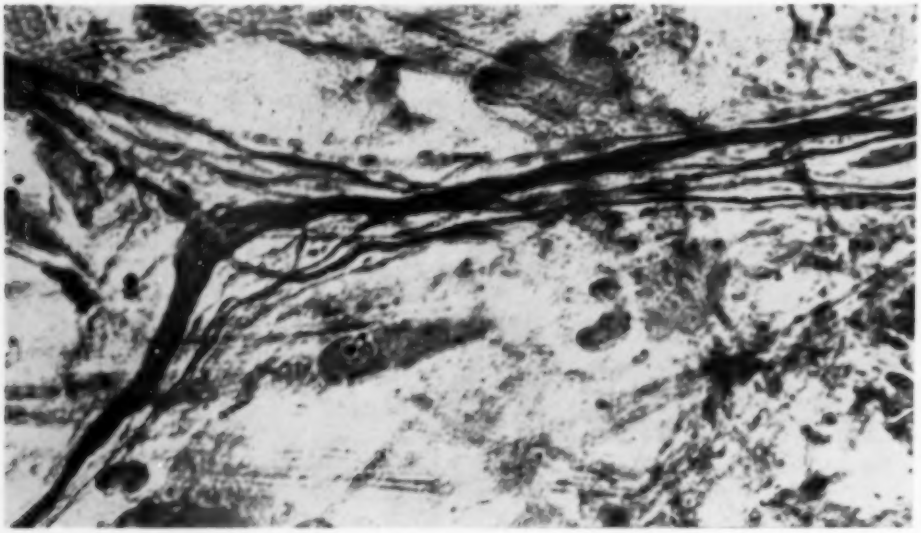


Fig. 10 (Scharenberg). Nerve bundle with one coarse myelinated fiber which enters the left branch; some of the thinner fibers cross to the opposite branch. (Photomicrograph ×800.)

nerves in the right branch (fig. 12).

The coarse nerve bundles are frequently connected by collaterals of three different types:

1. Collaterals which serve as bridges between two separate nerve bundles (fig. 13).

2. Collaterals which connect segments of the same nerve and are built of myelinated, occasionally linked, fibers, which later rejoin the nerve (fig. 14).

3. Collaterals which pass through the cytoplasm of a fixed cell and join the nerve

Fig. 11 (Scharenberg). Bifurcation of a nerve bundle the branches of which are distinctly different: the left branch contains a complicated interwoven plasmatic structure with numerous nerves; the right branch contains coarse fibers. (Photomicrograph ×400.)

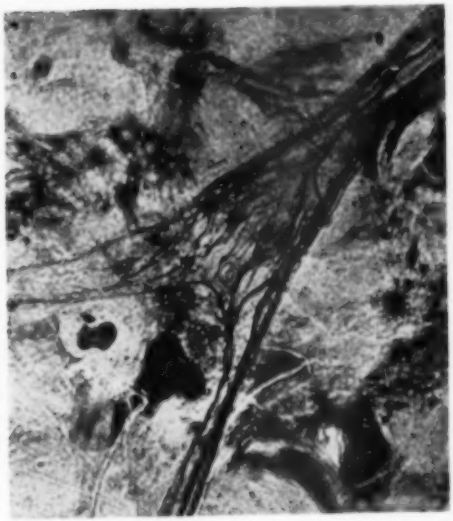


Fig. 12 (Scharenberg). A smaller (second) bifurcation with a few coarse fibers in the left branch and a delicate network in the right. (Photomicrograph ×400.)

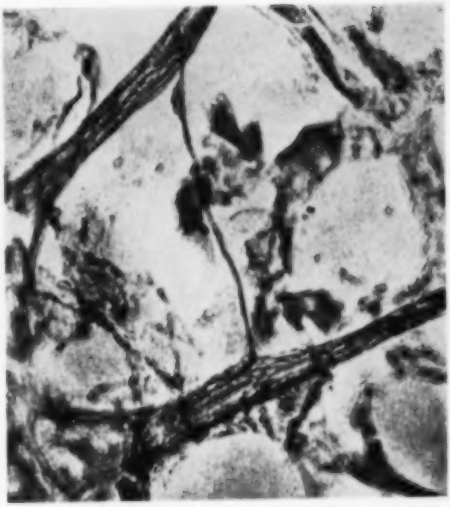


Fig. 13 (Scharenberg). A straight collateral which connects two separate nerve bundles. (Photomicrograph ×100.)

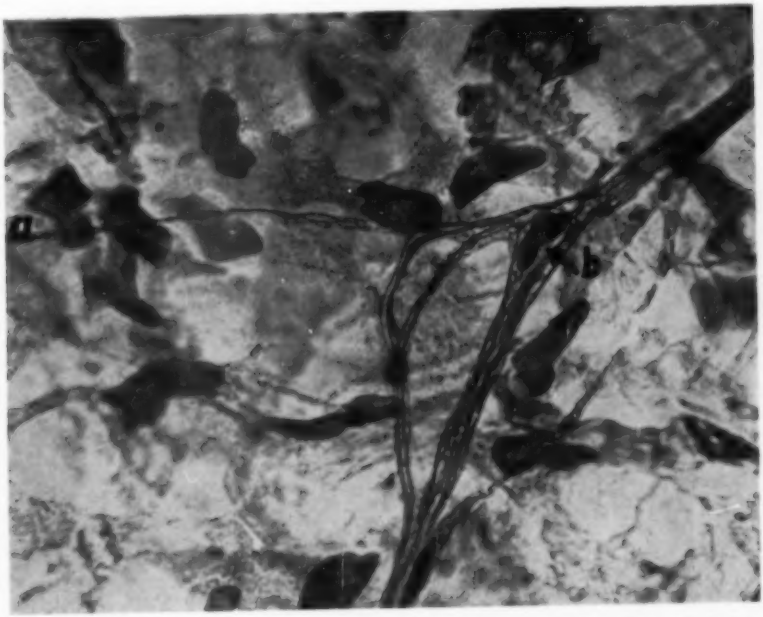


Fig. 14 (Scharenberg). Multiple arched collaterals which connect segments of the same nerve. At (a) there is an aberrant fiber. Note a large elongated nucleus of Schwann (b). (Photomicrograph ×100.)

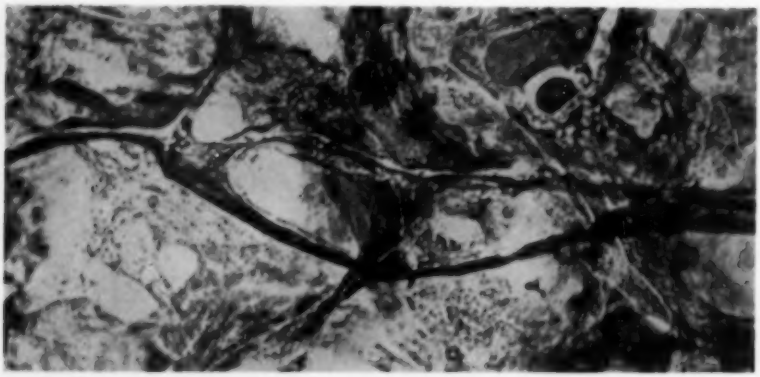


Fig. 15 (Scharenberg). A collateral which passes through the cytoplasm of a fixed cell, forms a synapse with it, and joins the nerve bundle again. (Photomicrograph ×400.)

bundle outside (fig. 15).

The coarse nerve bundles and their collaterals of Types 1 and 2 have no connections with the cytoplasm of the fixed cells, while in Type 3 there is a definite synapse the nature of which will be discussed later (fig. 15).

2. The relationship between cells and nerves

The nerves of the cornea are closely connected with the cytoplasm and with the nuclei of the fixed cells and there can be distinguished five different types of synapse:

1. The nerve shaped as a loop passes through the cytoplasm of several (6 to 8) cells, skirts their nuclei (fig. 16), or surrounds them with a net of fibers (fig. 17).

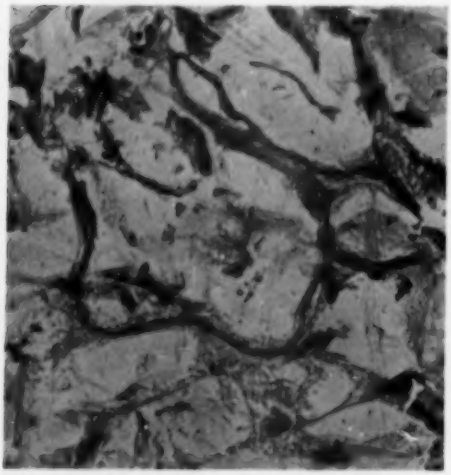


Fig. 16 (Scharenberg). A nerve shaped as a loop which passes through the cytoplasm of a chain of cells and skirts their nuclei. (Photomicrograph ×200.)

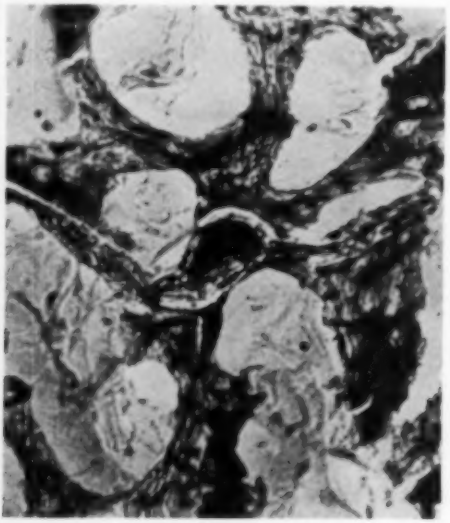


Fig. 17 (Scharenberg). A nerve which penetrates a fixed cell; its fibers surround the nucleus like a net. On the left the structures of the nerve merge imperceptibly with the cytoplasm of the fixed element. (Photomicrograph ×500.)

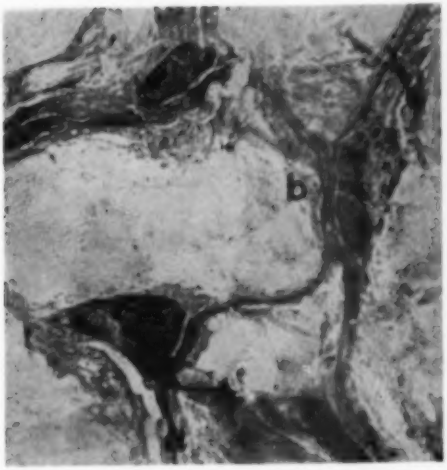


Fig. 18 (Scharenberg). Double "X" shaped intracellular bifurcation of a nerve which forms a distinct loop, skirts the nuclei (a), and merges with the cytoplasm of the fixed cells (b). (Photomicrograph ×400.)

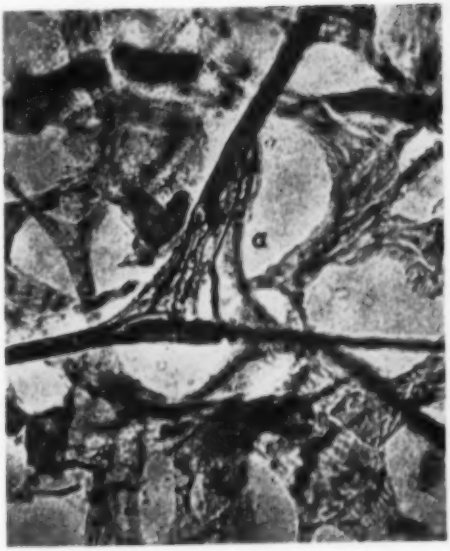


Fig. 19 (Scharenberg). A long plasmatic process of a Y-shaped fixed cell (a) enters the structure of a nerve in the areas of bifurcation. (Photomicrograph ×200.)

During the passage through the cell the structure of the nerve becomes strikingly similar to that of the surrounding cytoplasm with which it merges imperceptibly (figs. 15 and 17.

2. The nerve divides at the opposite poles of the nucleus thus forming an "X" shaped double intraplasmatic division (fig. 18).

3. The synapse may also be established at the triangular area of the bifurcation in which a long plasmatic process of a fixed cell enters the network of the elements of Schwann and becomes indistinguishable from it (fig. 19).

4. As already mentioned, the intraplasmatic contact can also be established by a collateral nerve fiber (fig. 15) which is in very close contact with the cytoplasm.

5. A delicate nerve fiber splits into two branches, one of which enters the cytoplasm between two nuclei and forms with it a distinct reticulum, while the other branch penefrates the nucleus, almost breaking it into two fragments, continues on its course, and is lost among the plasmatic structures of the fixed cells (fig. 20). The nerve fibers

Fig. 20 (Scharenberg). A delicate nerve fiber enters the cytoplasm of a fixed cell between two nuclei and forms a distinct preterminal reticulum (a); another branch of the nerve penetrates the nucleus and also merges with the cytoplasm. (Photomicrograph ×1,000.)

Fig. 21 (Scharenberg). Terminal nerve structure built of several parallel, arched fibers surrounded by a plasmatic halo (a), which skirt the nuclei, form numerous extracellular terminal varicosities which are connected with large epitheloid cells (b). (Photomicrograph ×1,000.)

do not terminate in the reticulum of the fixed cells but emerge from it, run between the elements of the cornea, join other nerve bundles or penetrate Bowman's membrane, and enter the epithelium. The nerves which form intracellular synapses differ in caliber and structure: some of them are relatively coarse, have a distinct myelin network and contain numerous elements of Schwann (figs. 15, 16, 17, 18, and 19), others appear as homogeneous and delicate fibers (fig. 20).

They have, so far as could be ascertained, no extracellular endformations in the cornea. There are, however, numerous terminal structures of a different type formed by several arched parallel nerve fibers which enter the cornea with the blood vessels of the limbus, skirt the nuclei of the fixed cells, and terminate with numerous verrucosities, some of which are connected with large epitheloid cells (fig. 21). The nerves of these terminal formations are built of twin fibers and are surrounded by a homogeneous plasmatic sleeve which stains a delicate pink with silver carbonate. This type of nerve fiber is peculiar to terminal structures of the peripheral nervous system. These formations are apparently identical with the "giant end bulbs" of Dogiel,[4] Knüsel and Vonwiller,[5] Kolmer,[6] and Engelbrecht[7] (1950).

3. The nerves of the epithelium

The nerves enter the epithelium from the subepithelial and intraepithelial plexuses and from the cornea. Numerous nerve fibers split from a larger stem and divide among the epithelial cells (fig. 22), or a coarse nerve bifurcates in the upper stratum of the cornea and its branches penetrate Bowman's membrane and the epithelium (fig. 5). The nerves maintain a close contact with the polymorph elements which they skirt and surround (fig. 23); numerous nerve fibers also enter the cytoplasm of the polymorph elements (fig. 24). These fibers are of various types and caliber; those which enter the cytoplasm are mostly delicate and homo-

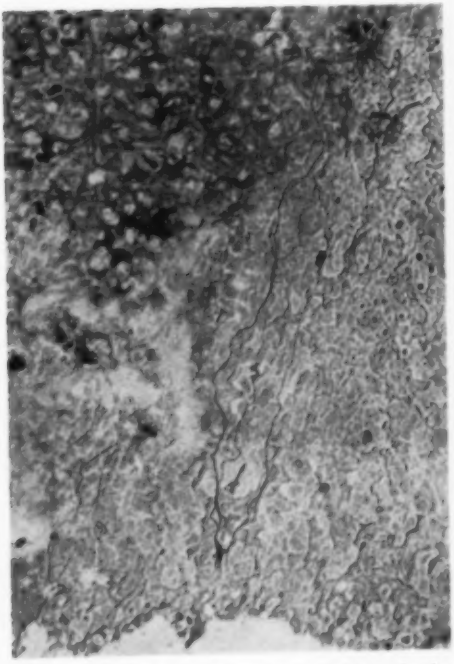


Fig. 22 (Scharenberg). Small nerve stem in the epithelium with numerous delicate branches. (Photomicrograph ×400.)

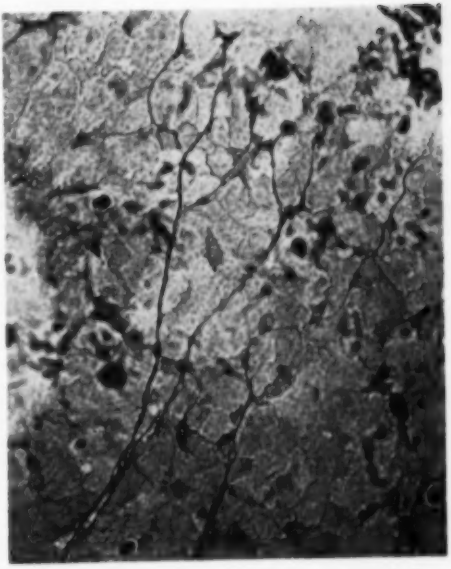


Fig. 23 (Scharenberg). Nerves of the epithelium which are in close contact with its elements; the nerves carry numerous T-shaped bifurcations. (Photomicrograph ×500.)

geneous, while the larger nerves are built of several fibers wound around each other, contain numerous beady swellings, and terminate with "T" shaped formations (fig. 22).

Comment

The study of the literature shows that the controversial problem of the relationship between the fixed cells and the nerves is still not settled. Some of the older authors—Conheim[8] (1867), Hoyer[9] (1873) Klein[10] (1880), Waldeyer[11] (1880)—assumed that there is a close contact between cells and nerves, while Arnstein[12] (1890), Agababow[13] (1812) Attias[14] (1812), and in recent years Martinez[15] (1940), and Zander and Weddel[16] (1952) denied it. Boecke[17] (1925) was able to show that the nerves actually pass through the cytoplasm of the fixed cells, but failed to demonstrate the histologic struc-

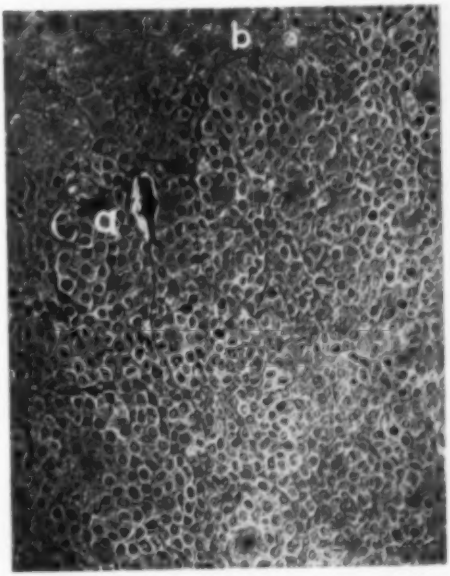


Fig. 24 (Scharenberg). Nerves of the epithelium which enter pear-shaped elements (a and b). (Photomicrograph ×800.)

ture of the cytoplasm-nerve contact.

Zander and Weddel disagreed with Boecke and stated . . . "that although single axons may be intimately related to the cytoplasm of corneal corpuscles for some distance, they do not enter them. . . ." Jabonero and Lorente[18] (1952), on the contrary, confirmed the findings of Boecke and in addition described delicate nerve fibers with terminal verrucosities in the cytoplasm and noted that some of these penetrate the nuclei.

Silver-carbonate preparations demonstrate minute details of the nerve-cell synapse with clarity which provides convincing microphotographic evidence. With this technique it is possible to show that a single nerve passes through the cytoplasm of a chain of cells and that the synapse is established with both the cytoplasm and the nucleus. The nerve fibers split into a delicate reticulum which merges with the cytoplasm, surrounds the nuclei, penetrates and pierces their structure. However, the intracellular reticulum, strictly speaking, does not represent a terminal formation since following the synapse the nerve fibers emerge again, run between the elements of the cornea without establishing further contact with the cells, and finally join other nerve bundles or enter the epithelium; that is, the nerves which form intracellular synapse have neither extracellular nor intracellular end-formations in the cornea.

The reticulum of the intracellular synapse was regarded by Boecke as a "terminal network." This designation is not quite correct since the nerve fibers do not terminate in the cytoplasm, and therefore the designation "preterminal network" seems to be more fitting.

The syncytial character of the cornea and the intracellular synapse insures so close a contact between cells and nerves that there can be no doubt that Boecke was right when he stated that in the cornea there are no boundaries between mesoderm and ectoderm.

In addition to the intracellular synapse there are terminal formations of the so-called "sensory" type which are also connected with the elements of the cornea since they skirt the nuclei. They do not form a reticulum in the cytoplasm but end outside of the cells with numerous verrucosities which are surrounded by large "epitheloid" elements. These structures represent terminal formations.

The histologic structure of the innervation of the epithelium is no less complicated than that of the cornea and is not fully understood. Boecke showed that the nerves enter the epithelial elements where they form small rings in the cytoplasm near the nucleus. Egorow[18] (1832), described distinct end-swellings and "Eimers bodies" built of a network of delicate nerve fibers which surround a group of "epitheloid" cells. He also noted cells with irregular processes which surround the columnar epithelium. These cells are obviously identical with the polymorph elements which penetrate Bowman's membrane, serve as connecting elements between the cornea and the epithelium, and are connected with the nerves.

University Hospital.

References

1. Prieto Diaz, H.: La technica del carbonato argentico amoniacal de del Rio Hortega en el estudio del tejido propio de la cornea. Arch. histol. norm. y pat., **3**:513, 1947.
2. Sverdlick, J.: Study of keratocytes by means of del Rio Hortega's method of silver impregnation. Read before the XVII Internat. Cong. Sept. 17, 1954, New York.
3. Friedenwald, J. S.: Ophthalmic Pathology. Philadelphia, Saunders, 1952.
4. Dogiel, A. S.: Die Nervened Körperchen in der Cornea und Conjunctiva Bulbi des Menschen. Arch. f. mikro. Anat., **37**:602, 1891.
5. Knüsel, O., and Vonwiller, P.: Vitale Färbungen am Menschlichen Auge. Ztschr. f. Augenh., **49**: 157, 1852.
6. Kolmer, W.: Zur Histol. der Augenhäute; Anat. Anz., **47**:417, 1914-15.

7. Engelbrecht, W.: Die epithel. und subepith. Nervenendigungen der menschl. Hornhaut. Arch. f. Ophth., **154**:65, 1953.
8. Conheim, J.: Ueber die Sensiblen Nerven der Hornhaut. Virch. Arch. path. Anat., **38**:343, 1867.
9. Hoyer, H.: Ueber die Nerven der Hornhaut. Arch. f. mikros. Anat., **9**:220, 1873.
10. Klein, E.: On the termination of the nerves in the mammalian cornea. Quart. J. Micro. Sc., **20**: 459, 1880.
11. Waldeyer, W., and Yzquierdo: Ueber die Endigundsweise der Sensiblen Nerven. Arch. f. mikro. Anat., **17**:367, 1880.
12. Arnstein, C.: Quoted from Agababow, A: Ueber die Nerven in Augenhauten. Arch. f. Ophth., **83**: 207, 1912.
13. Agababow, A.: Ueber die Nerven in Augenhauten. Arch. f. Ophth., **83**:207, 1912.
14. ———: Die Nerven der Hornhaut des Menschen. Arch. f. Ophth., **83**:207, 1912.
15. Martinez, R.: Etitude sur l'innervation de la cornie humaine. Trab. Inst. Cajal., **32**:75, 1940.
16. Zander, E., and Weddel, G.: Observations on the innervation of the cornea. J. Anat., **85**:68, 1952.
17. Boecke, J.: Die intracelluläre Lage der Nervenendigungen im Epithelgewebe und ihre Beziehungen zum Zellkern. Ztschr. f. Zellforsch., **2**:391, 1925.
18. Jabonero, V., and Lorente, J.: The relations of the nerve fibers with the connective tissue cells of the human cornea. Anat., **16**:184, 1952.
19. Egorow, J.: Nervenelemente der Cornea des Merschweichens. Arch. f. Ophth., **131**:531, 1934.

CATARACT INDUCED BY IODOACETIC ACID*

A PRELIMINARY REPORT

PAUL A. CIBIS, M.D.
Saint Louis, Missouri
AND
WERNER K. NOELL, M.D.
Buffalo, New York

INTRODUCTION

Iodoacetic acid is known to be an inhibitor of enzymes containing sulfhydryl groups. It exerts a selective effect on structures and function of the retina.[1,2] It impairs the electroretinogram and produces death of the rod-cell population in an irreversible and almost selective fashion. The last-named effect manifests itself microscopically as pyknosis of the rod nuclei followed by degeneration and disappearance of the outer retinal layers with complete absence of phagocytosis.

In recent experiments,[3,4] it has been found that high intensity X-radiation is able to produce functional and histologic changes within the mammalian retina which, to a great extent, resembles those observed in the iodoacetic acid experiments.[2] From the similarity of effects of iodoacetic acid and X ray on the retina, it became of interest to determine whether iodoacetic acid also produces changes in the lens similar to those produced by X-radiation.

MATERIAL AND METHOD

The material of the clinical study comprises 30 normal and three iodoacetic-acid poisoned New Zealand white rabbits; that of the histologic study comprises 10 normal and seven iodoacetic-acid poisoned New Zealand white rabbits. The intravenous solution of recrystallized iodoacetic acid was neutralized by sodium hydroxide immediately before injection. An initial dose of 20 mg./kg. body weight was followed six to eight hours later by a second injection of 15 to 20 mg./kg. body weight.

The electroretinogram was used as a guide and indicator for the effectiveness of the treatment. On recovery of the electroretinogram and of the light reflex, injection

* From the Departments of Ophthalmology and Neuropsychiatry, USAF School of Aviation Medicine, Randolph Field, Texas.

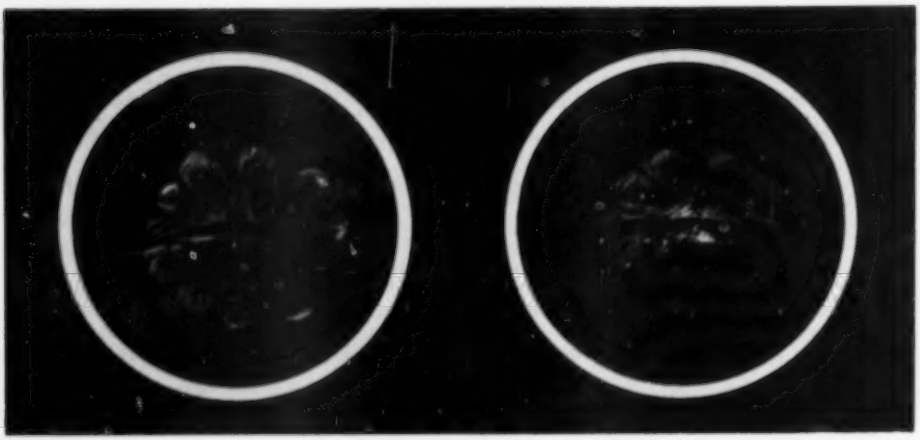


Fig. 1 (Cibis and Noell). Clinical appearance of cataract formation in rabbit two months after treatment with iodoacetic acid as seen with the biomicroscope. The opacities were located at the posterior cortex; vacuoles and dustlike opacities in front of the denser cataractous changes. Semischematic drawing.

of 15 to 20 mg. iodoacetic acid/kg. body weight was repeated once or twice within the following 24 hours. When the electroretinogram was irreversibly abolished, no further iodoacetic acid was administered.

No serious signs of drug effect developed after injection, except for visual impairment and one or two days of general weakness. A more detailed account of the technique used may be found in Noell's recent study on the electrophysiology and metabolism of the retina.[3]

The animals were killed two months following treatment. The eyes were immersed in Zenker's fixative immediately after enucleation.

Pathologic clinical findings

The external clinical appearance and the fundi of the eyes of treated animals were normal.

The cataractous changes in all treated animals were quite similar and consisted of diffuse opacification of the posterior cortex. In contradistinction to the suture developmental anomalies normally seen in rabbits, the iodoacetic-acid cataract is accompanied by numerous vacuoles, granular opacities anterior to the amorphous opacities, and subcapsular iridescence. Occasionally, polychromatic crystals were found interspersed among the anterior lamina of the amorphous opacities. Anomalous sutures developed in one case.

Pathologic findings

The histopathologic changes involved cornea, iris, ciliary body, choroid, retina, and lens. The endothelial cells of the cornea showed swelling of the cytoplasm. In general, choroid and iris showed atrophy and dense fibrosis as did the ciliary body and its processes. The retina exhibited degeneration of its outer layers and pigment epithelium over a large area (fig. 2), less marked in the region at and close to the ora serrata. One case was complicated by a severe iridocylitis and therefore excluded.

The histologic changes in the lenses consisted of (1) swelling of the lens fibers; (2) deformation and displacement of epithelial cells as well as bladder cell formation at the equator and posterior subcapsular region; (3) a more or less extensive accumulation of amorphous debris in the posterior cortex; (4) vacuole formations in the posterior cortex.

The lens capsule of one animal showed

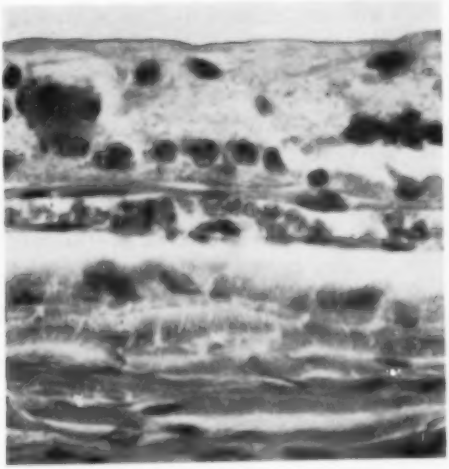


Fig. 2 (Cibis and Noell). Degeneration and complete disappearance of outer layers of retina two months after iodoacetic-acid treatment. Choroid reduced to a small capillary space between retina and sclera. Pigment epithelium disappeared. (Zenker, hematoxylin-eosin, ×660.)

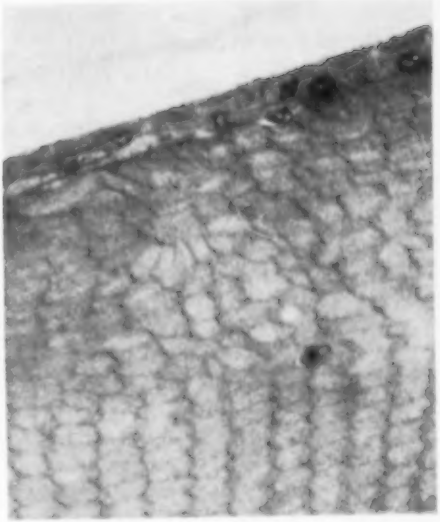


Fig. 3 (Cibis and Noell). Iodoacetic-acid cataract. Lens fiber swelling, displacement of nuclei disorganization of cellular structure and disturbed transition of aberrant cells into lens fibers. (Zenker, hematoxylin-eosin, ×440.)

circumscribed swelling and subcapsular edema, in conjunction with relative disintegration of cellular structure and degeneration of the underlying epithelium. At the nuclear bow, the configuration of the nuclei appeared disturbed, suggesting abortive differentiation of subcapsular epithelial cells into lens fibers (fig. 3). In general, the lens fibers appeared swollen and the almost 1:1 ratio of normal diameters of nuclei to cross section of lens fibers altered in favor of the latter, changing in some instances to 1:4 or more. Backward displacement of cell nuclei and their variation in size, shape, and staining properties, as well as the abortive attempt of subcapsular epithelium to form lens fibers, resulting in balloon cells (fig. 4), were further indications of disturbed transformation of epithelial cells into lens fibers.

At the stage at which the animals were killed, mitosis was observed occasionally when the equatorial epithelium was cut slightly tangentially. Since von Sallmann[5] reported that X-radiation impairs mitosis during the first days after exposure, the in-

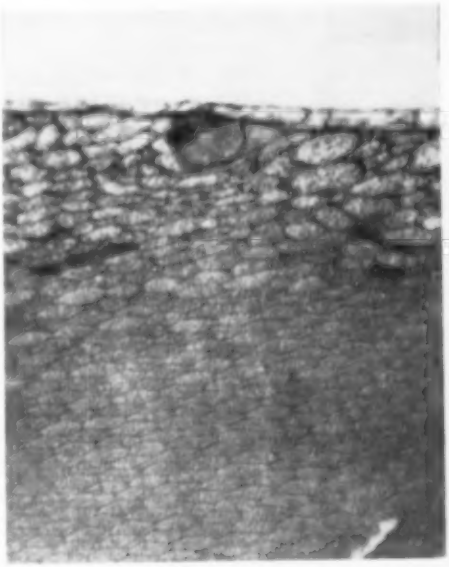


Fig. 4 (Cibis and Noell). Iodoacetic-acid cataract, lens fiber swelling, bladder-cell formation. (Zenker, hematoxylin-eosin, ×440.)

fluence of iodoacetic acid on the mitosis index is under investigation.

Discussion

The clinical and histologic changes associated with the development of iodoacetic-acid cataract do not seem to be specific. Similar pictures may be found in cases of the so-called cataracta complicata seen in connection with chronic iridocyclitis, retinitis pigmentosa, and other endogenous ocular or systemic diseases. However, there is a striking parallelism between manifestations of iodoacetic-acid cataract and those observed in radiation cataract. Both types are characterized by disintegration and backward migration of cells along the inner surface of the posterior capsule, fiber swelling, and bladder-cell formation beneath the posterior capsule (Cogan, *et al.*[6,7]).

It is of considerable interest that iodoacetic acid and ionizing radiation produce similar types of cataract as well as deleterious effects on the visual cells which are almost identical as to time of development, histopathology, and functional change (electroretinogram).

Moreover, the fact that iodoacetic acid represents an inhibitor of sulfhydryl containing enzymes, which are important to the metabolism and energy supply of the cell, bears with it the hope than an extensive, clinical, histologic, and biochemical study may cast some light on the various aspects of cataractogenesis. Further experiments are underway.

Summary and Conclusions

The clinical and histologic features of cataract produced in three adult New Zealand white rabbits by repeated intravenous injections of iodoacetic acid (20 mg./kg. body weight) are described.

The cataracts developed in the posterior cortex and were accompanied by vacuole formation, granular white and polychromatic opacifications, and anomalous suture-like clefts.

The histologic changes of iodoacetic-acid cataracts have been studied in seven rabbits. They consisted of (1) lens fiber swelling, (2) disorganization and failure of the cells at the equator to differentiate into normal lens fibers, (3) migration of aberrant cells beneath the posterior capsule and formation of bladder cells, (4) development of globular and amorphous masses in the posterior cortex.

Within certain limitations, the iodoacetic-acid cataract resembles clinically and histologically the radiation cataract.

640 South Kingshighway Boulevard (10).

References

1. Noell, W. K.: The effect of iodoacetate on the vertebrate retina. J. Cell. & Comp. Physiol., **37**:283-307, 1951.

2. ———: Studies on the electrophysiology and the metabolism of the retina. USAF School of Aviation Medicine Project Report 21-12-1-0004, Randolph Field, Texas.

3. Noell, W. K., Eichel, B., and Cibis, P. A.: Visual cells and pigment epithelium after high intensity X-radiation. Federation Proc., **13**: No. 1 (Mar.) 1954.

4. Cibis, P. A., Noell, W. K., and Eichel, B.: Biological and medical aspects of ionizing radiation: I. Clinical and histological observations of radiation damage occurring in the mammalian eye. USAF School of Aviation Medicine Project No. 21-3501-0005, Report No. 1, Randolph Field, Texas.

5. von Sallmann, L.: Report on studies of the effect of roentgen irradiation on the rabbit lens. U.S. Atomic Energy Commission Declassified Document No. NYO-1508, April, 1950. Abstracted Nuclear Sc. Abstr., **4**:631 (July) 1950; Experimental studies on early lens changes after roentgen irradiation. Arch. Ophth., **45**:149, 1951.

6. Cogan, D. G., and Donaldson, D. D.: Experimental radiation cataracts. I. Cataracts in rabbits following single X-ray exposure. Arch. Ophth., **45**:508-522, 1951.

7. Cogan, D. G., Donaldson, D. D., and Reese, A. B.: Clinical and pathological characteristics of radiation cataract. Arch. Ophth., **47**:55-70, 1952.

TRICHIASIS SURGERY IN TRACHOMA*

A REPORT OF 700 CASES

RICHARD BUTTON, M.D.
Newport Beach, California
AND
M. ZAKI ABDUL KADER, M.D.
Baghdad, Iraq

INTRODUCTION

Surgical correction of entropion with trichiasis in cicatricial trachoma necessarily involves the removal or the correction of the badly deformed tarsus which is the causative factor in this condition. In the final cicatricial stage of trachoma there occurs a contraction of the conjunctiva, initially with a scarring and deformity of the tarsus which acts to produce an entropion and inturning of the lash line, resulting in further insult to an already damaged cornea. Therefore any surgery to correct this condition must be directed toward straightening a deformed tarsus and repositioning the free margin of the lid to correct the trichiasis.

CHOICE OF CASES

All of the cases included in this series were classified as inactive or stage IV trachoma according to the MacCallan classification[1] and all were accompanied by scarring and deformity of the tarsus, to a varying degree, producing both entropion and trichiasis. A total of 700 cases were collected by us and surgical correction of the type to be described has been performed in all cases due to trachoma. The same surgical technique was used in 600 cases corrected at the Ophthalmic Hospital in Baghdad and in the 100 cases done at the Navajo Medical Center in Arizona, except for the additional use of a thin rubber peg or bolster in the cases performed at the Navajo Medical Center.

HISTORY

In 1857 Anagnostakis[2] corrected entropion with trichiasis by making an incision through the skin of the lid margin three mm. above and parallel to the margin. He continued this incision down to the tarsus, excising some of the fibers of the orbicularis muscle, and sutured the lower skin edge to the upper margin of the tarsus. His was an attempt to correct the entropion by creating tension between the lid border and the fixed upper border of the tarsus.

A year later, Streatfeild[3] introduced an operation in which a wedge-shaped area of the tarsus was removed but no sutures were used to approximate or close the tarsal defect.

This procedure was further modified by Snellen,[4] in 1862, who introduced the use of sutures to close the tarsal defect correcting the entropion and trichiasis. These sutures were brought out just above the lash line and were tied over glass beads.

Since the introduction of this type of procedure, many other variations have appeared in the literature but the most popular is the Hotz-Anagnostakis operation[5] in which a wedge-shaped area of tarsus is removed together with resection of the overlying hypertrophied orbicularis muscle.

Further modifications were introduced by Panas[6] who performed a tarsotomy of the deformed tarsus in 1888, and Mueller[7] who incorporated a type of procedure where the free margin of the lid was rotated. Pagenstecher[8] offered a further modification, excising a wedge of tarsus from the middle portion rather than further down toward the lash line.

Later contributions came from Kiep,[9] in 1924, who published a modification of Snellen's original operation in which a continuous suture was used to close the tarsal wedge. Busacca,[10] in 1936, again proposed the removal of the overlying orbicularis

* From the Department of Ophthalmology, Navajo Medical Center, Fort Defiance, Arizona.

muscle together with thin slices of the tarsus. He believed that the principal factor in the entropion was the hypertrophied orbicularis muscle. Still later, in 1950, Djacos[11] published a report which once again utilized the principle of correction of the badly deformed tarsus by removing a wedge from its surface.

Surgical technique

The surgical technique used to correct the entropion and trichiasis in this series of 700 cases utilizes the same surgical principles already mentioned and offers a further modification of the Hotz-Anagnostakis operation. This procedure is especially applicable to the upper lid but is not to be recommended for marginal trichiasis in which some other operations, such as the Spencer-Watson procedure, are more effective.

Local infiltration with two-percent procaine provides adequate anesthesia when injected into the retrotarsal conjunctiva and along the entire upper lid. The additional use of a lid-plate inserted beneath the upper lid provides both protection for the cornea and helps with hemostasis, since some pressure may be exerted with this plate.

The initial incision is made three to four mm. from the lid margin, as shown in Figure 1-A, and runs parallel to the lid margin for the entire length of the tarsus. This incision is carried down to the diseased tarsus, care being taken not to injure the lash bed.

The hypertrophied orbicularis muscle fibers are removed, as shown in Figure 1-B, exposing the tarsus which is completely dissected free without disturbing the attachments of the levator.

A wedge-shaped area of tarsus approximately six-mm. wide, depending on the state

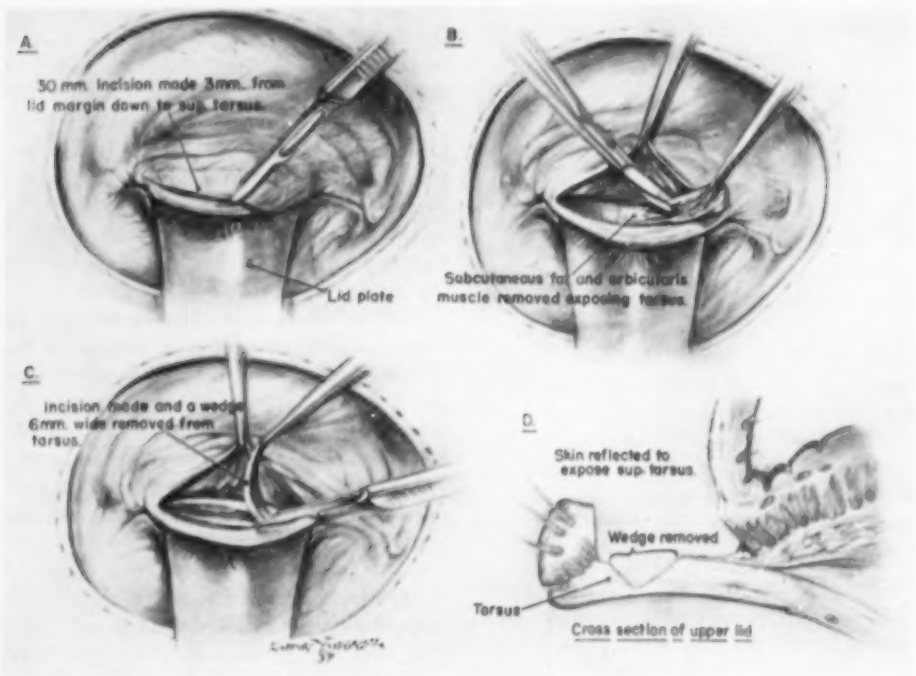


Fig. 1 (Button and Kader). Steps in the trichiasis operation.

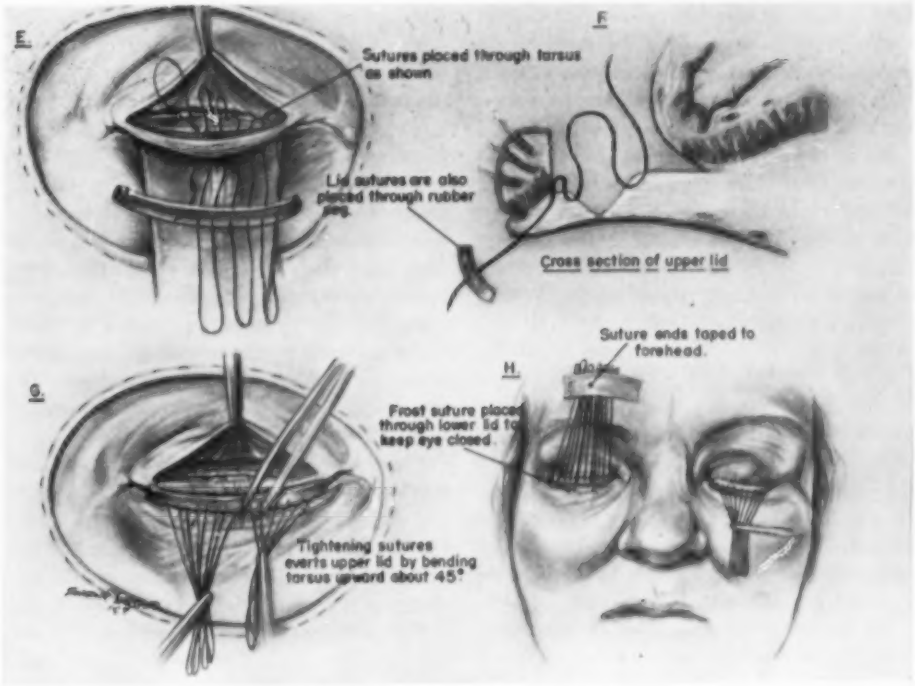


Fig. 2 (Button and Kader). Steps in the trichiasis operation.

of the tarsus, is then dissected free as shown in Figure 1-C. This incision tapers laterally and medially, and care is taken so as not to perforate the tarsal conjunctiva. In Figure 1-D, a cross section of this procedure is shown with the upper skin edge reflected.

A thin rubber bolster or peg is then prepared so as to run the entire length of the lid and through this the continuous 4-0 silk suture is introduced, as in Figure 2-E. This suture, after emerging from the rubber peg, is introduced behind the gray line of the lid, as shown in Figure 2-F, and emerges at the inferior lip of the tarsal wedge. The suture then is passed through the superior lip of the tarsal wedge as shown in the diagram. A good bite in the superior tarsus is necessary since this is the anchor point for the entire correction.

The suture next is re-introduced several millimeters adjacent to the point of exit in the superior tarsus and the same course is followed in reverse order allowing the suture to emerge behind the gray line. In this fashion a continuous type of mattress suture approximates the edges of the tarsal wedge everting the lid border.

This suture may be tightened giving the desired correction simply by forcing the rubber bolster against the lid margin as shown in Figure 2-G. The original skin incision may be closed with interrupted silk sutures or may be left alone since the forehead suspension of the sutures will allow excellent approximation of the skin edges. However, care must be taken that the skin edges are not inverted or proper healing will not occur.

In Figure 2-H, the mattress sutures are shown taped to the forehead. A Frost lid suture was used in all cases to protect the cornea. Local erythromycin ophthalmic oint-

ment is instilled into the conjunctival sac and a dressing is applied. This dressing is changed on the second postoperative day and the sutures are removed on the fifth postoperative day.

All of the cases performed at the Navajo Medical Center were preoperatively placed on oral erythromycin tablets given in an adult dosage of 100 mg. four times daily. This was kept up until the sutures were removed to prevent any recurrence or flareup of the trachoma.

Summary and Conclusion

The chief value of this procedure over others employing the same surgical principles is that extreme lid deformities can be corrected by placing the sutures behind the gray line. The degree of correction may be increased by increasing the width of the tarsal wedge, although a slight amount of shortening occurs with extreme corrections.

By utilizing the thin rubber bolster, it was not necessary to tie each individual suture and any desired correction could be obtained simply by exerting more or less traction on this rubber bolster. It also tended to maintain the normal configuration of the lid margin without distortion.

This procedure is felt to be the one of choice for those cases due to trachoma in which there is intense scarring of the tarsus with entropion and trichiasis. The chief contraindications are cases of marginal trichiasis. The greatest correction is found to be adjacent to the area of greatest tarsal resection and, in general, the lower the tarsal wedge is placed the better the correction.

Careful preoperative preparation with oral erythromycin prevents or lessens the danger of reactivation of the trachoma under the dressing. There was no case in this series in which there was excessive discharge.

419 North Newport Boulevard.

References

1. MacCallan, A. F.: Trachoma and Its Complications in Egypt. London, Cambridge Univ. Press, 1913, p. 5.
2. Anagnostakis, A.: Remarques pratiques sur le traitement du trichiasis. Ann. ocul., **38**:5-14, 1857.
3. Streatfeild: On grooving the fibro-cartilage of the lid in cases of entropion and trichiasis. Ophth. Hosp. Reports, London, **1**:121-130, 1858.
4. Snellen, H.: Modifications a l'operation de l'entropion. Cong. period. internat. d'ophtal., **2**:236-238, 1862.
5. Hotz, F. C.: A new operation for entropion and trichiasis. Arch. Ophth., **8**:249-263, 1879.
6. Panas: Traitement operatoire de l'entropion granuleux. Bull. med. Paris, **2**:827, 1888.
7. Mueller, L.: Die trichiasis-operation nach Panas. Klin. Monatsbl. f. Augenh., **31**:345-349, 1893.
8. Pagenstecher, H., and Scheffels, O.: Ueber Vorlagerung der Levatorsehne: Ein neues Operationsverfahren. Arch. f. Ophth., **36**:4, 265, 1890.
9. Kiep, W. H.: Modification of Snellen's operation for entropion and trichiasis. Tr. Ophth. Soc. U. Kingdom, **44**:372-375, 1924.
10. Busacca, A.: Method of correction of entropion in trachomatous patients: With particular regard to esthetic results. Arch. Ophth., **16**:822-828, 1936.
11. Djacos, C.: Entropion and trichiasis: Solution of the surgical problem. Ann. ocul., **183**:943-956, 1950.

ANGIOID STREAKS WITH PSEUDOXANTHOMA ELASTICUM*

A CASE FOLLOWED BY FUNDUS PHOTOGRAPHY OVER A PERIOD OF 27 YEARS

A. BENEDICT RIZZUTI, M.D.
Brooklyn, New York

Since Doyne[1] first described angioid streaks of the fundus oculi, in 1887, over 200 cases have been reported in the literature. The diagnosis is readily made by recognition of a typical ophthalmoscopic picture.

The fundus shows the presence of a bizarre network of ragged pigmented striations which appear to lie between the retinal and choroidal vascular beds. Knapp[2] called the streaks angioid because of their blood vessel-like appearance and distribution. They are commonly found to co-exist with one of the following conditions:

1. Pseudoxanthoma elasticum
2. Paget's disease (osteitis deformans)
3. Generalized vascular disease

OPHTHALMOSCOPIC PICTURE

In the typical case the fundus presents a more or less complete peripapillary pigmented ring with off-shoots extending toward the equator in a radial distribution. In the early stages the streaks usually appear red but later may assume a gray, brown, or black color. At times, a white sheathing is seen in conjunction with the streaks which is probably of connective tissue origin. The streaks are flat, serrated, and may be several times wider than a retinal vein. They gradually taper off toward the periphery of the fundus where they may then appear as thin lines. They do not branch dichotomously as do the retinal vessels and in general they give the appearance of cracks in dry mud.

The macular region is usually involved in varying degree, with the presence of fresh hemorrhages, exudates, or old scars with excessive clusters of dark pigment. The periphery of the fundus may show an occasional chorioretinal lesion. There is frequently seen a dustlike pigment stippling which appears to be rather peculiar to the disease.

The condition as a rule is equally divided between the sexes and is most commonly found between the second and fifth decades of life. Both eyes are invariably involved. The visual fields remain normal but the disease takes on a chronic progressive course because of the severe macular degeneration that usually ensues. In the final stages the picture can resemble one of senile disciform macular degeneration. It is imperative for the ophthalmologist to recognize the disease early in its course so that the prognosis may be guarded.

The following case is presented because it depicts photographically the fundus findings which show the chronic progressive macular degeneration that usually occurs over a period of many years.

CASE REPORT

A 16-year-old white boy was first examined on June 7, 1927, by Dr. Wendell L. Hughes.[3] His chief complaint was of a gradual loss in vision of the left eye. He attributed the change to a direct injury received while playing basketball.

Corrected vision was reported as 20/70 in each eye. The periorbital structures and the anterior ocular segments were essentially normal. Excellent ocular motility was present and no unusual eye findings were recorded except for the presence of angioid streaks of the fundi. These streaks were typical in distribution and grayish brown. The left eye presented a macular hemor-

* From the Holy Family Hospital, St. Peter's Hospital, and the Brooklyn Eye and Ear Hospital. Presented at the Brooklyn Eye and Ear Hospital, November, 1954.

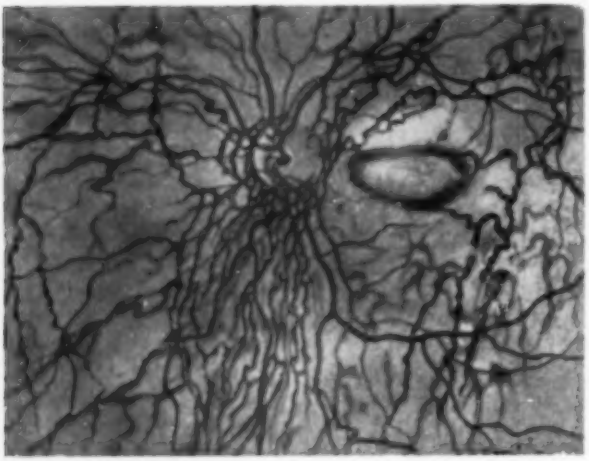


Fig. 1 (Rizzuti). Angioid streaks lie between the retinal and choroidal vessels. A partially absorbed subretinal hemorrhage is present in the macular area. June, 1928: Corrected vision, left eye, 20/70. (Case reported by Dr. Wendell L. Hughes.)

rhage which measured about two papillary diameters. No mention was made at that time of the presence of pseudoxanthoma elasticum. One year later, Dr. Hughes noted that the hemorrhage in the left macular area had been partially replaced by a connective tissue mass. A painting of the fundus, made at that time, has been photographically reproduced (fig. 1).

In November, 1941, 14 years later, the patient reported for re-examination to the New York Eye and Ear Infirmary. A review of the hospital record at that time showed the corrected vision of the right eye to be 20/70 and an absence of any macular involvement. Corrected vision of the left eye was noted as 20/200 and the macula now presented a large darkly pigmented area of raised pigment which measured about four papillary diameters. The angioid streaks of both fundi appeared dark brown and in the retinal periphery there was noted evidence of early fine pigmentary stippling.

The patient was first examined by me on March 5, 1949. The corrected vision was 20/200 in the right eye and 4/200 in the left. Routine external eye examination proved to be essentially normal. Angioid streaks of the fundi were easily identified and they appeared dark brown. The macular areas were markedly involved by large blotchy darkly pigmented areas of degeneration. These changes were associated with profuse connective tissue scars and scattered areas of hemorrhage. The retinal and choroidal vessels appeared to be of normal outline. Fine, dark pigmentary mottling was noted in the extreme periphery of both fundi (figs. 2 and 3). The patient also presented a typical picture of pseudoxanthoma elasticum.

Biopsy study of a portion of skin taken from the inner aspect of the upper arm revealed the usual histopathologic changes; mainly, atrophy of the epidermis and de-

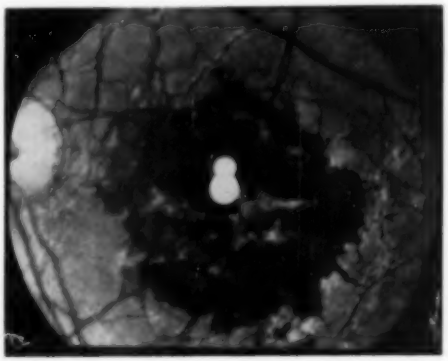


Fig. 2 (Rizzuti). Angioid streaks. March, 1949: Corrected vision, left eye, 4/200. Note marked pigment changes in macular area.

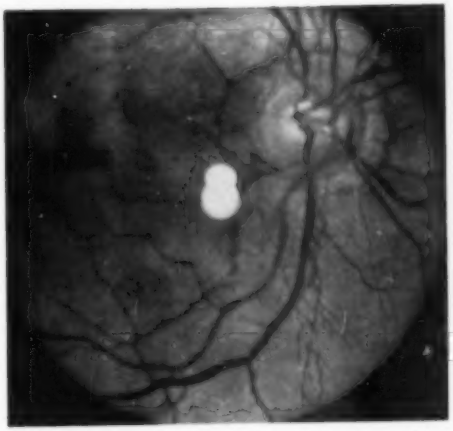


Fig. 3 (Rizzuti). Angioid streaks. March, 1949: Corrected vision, right eye, 20/200. Diffuse hemorrhage in macular region.

generation of the elastic fibers of the midcorium (figs. 4 and 5).

Roentgenologic studies of the skull, long bones, and pelvis did not show the presence of Paget's disease.

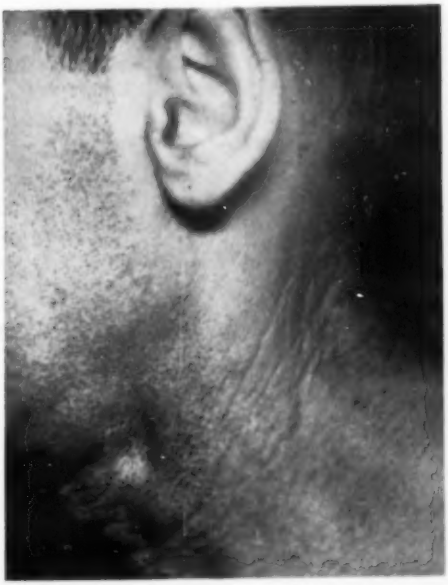


Fig. 4 (Rizzuti). Pseudoxanthoma elasticum characterized by excessive striae of skin associated with yellow stippling and mottling.

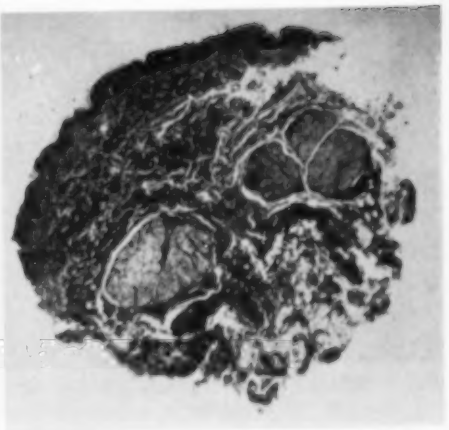


Fig. 5 (Rizzuti). Low-power microscopic section of skin in pseudoxanthoma elasticum. Atrophy of superficial skin layer; degeneration of elastic fibers in the midcorium.

The patient stated that he had two mute sisters and one mute brother; none of them had any particular eye complaints. His three sons later reported for examination but all failed to reveal any evidence of angioid streaks or other associated diseases. The patient was kept under observation and followed periodically. Photographs of the fundi taken in May, 1952, revealed a progression of the disease (figs. 6 and 7).

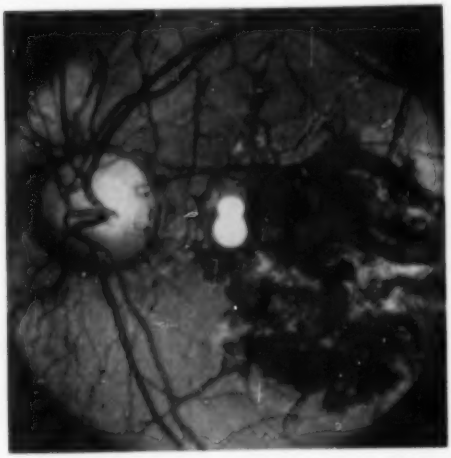


Fig. 6 (Rizzuti). Angioid streaks. January, 1952: Corrected vision, left eye, 2/200.

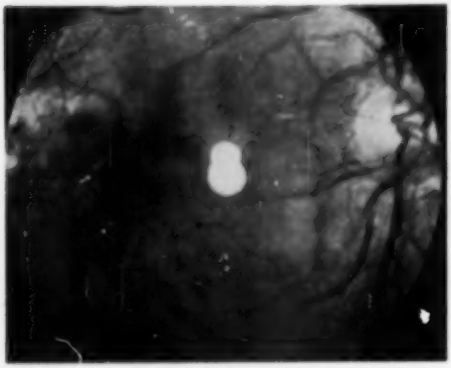


Fig. 7 (Rizzuti). Angioid streaks. January, 1952: Corrected vision, right eye, 10/200.

Every form of therapy employed failed to stop the progress of the disease. He was last examined on July 10, 1954, at which time the vision in the right eye had further decreased to 3/200 and in the left to counting fingers at 10 inches. Macular degeneration in each eye was very pronounced and was characterized by excessive pigment deposits with marked scar formation (figs. 8 and 9).

Although the visual fields were not materially impaired, the man became almost totally incapacitated and had to be referred to an industrial home for the blind to carry on with some type of occupation.

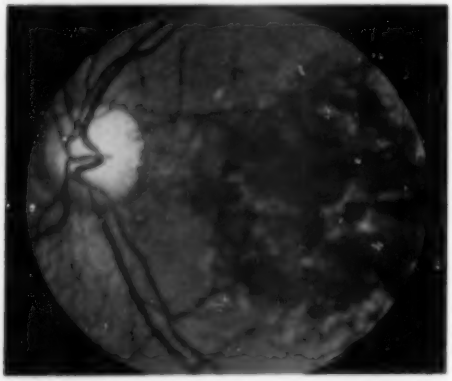


Fig. 8 (Rizzuti). Angioid streaks. May, 1954: Corrected vision, left eye, counting fingers at 10 inches. Pigment and old hemorrhages replaced partially by fibrous tissue.

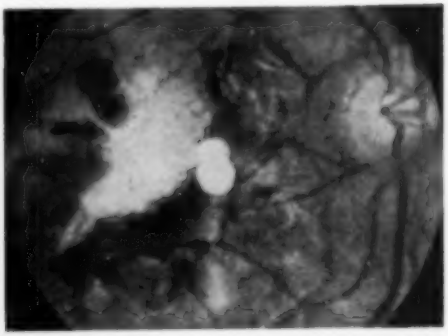


Fig. 9 (Rizzuti). Angioid streaks. May, 1954: Corrected vision, right eye, 3/200. Marked scar-tissue changes in the macular region.

Discussion

Several theories have been expounded as to the origin of angioid streaks. The one that has enjoyed the greatest popularity is that of Kofler[4] who, in 1917, was of the opinion that the streaks were a result of tears in Bruch's membrane of the choroid.

Verhoeff[5] and later Klien[6] demonstrated by histologic studies in enucleated eyes that there does exist a diffuse degeneration of the elastic layer of Bruch's membrane. This was characterized by numerous ruptures and calcium deposits which they thought accounted for the hemorrhages and other changes of the underlying choriocapillaris.

As recently as June, 1954, Cowper[7] disputed this theory and concluded that the streaks represented excessively pigmented vessels of the choroid. Unfortunately, he did not substantiate his theory with any microscopic sections.

In 1903, Hallopeau and Laffitte[8] reported pseudoxanthoma elasticum in a case in which there was a peculiar fundus picture. Groenblad,[9] in 1929, in conjunction with Strandberg reported two cases of angioid streaks associated with pseudoxanthoma elasticum (Groenblad-Strandberg syndrome). Pseudoxanthoma elasticum was first described in 1888 by Balzer[10] and named by Darier[11] in 1896.

Clinically, it is recognized by a faint yellow discoloration of the skin especially in

areas where excessive movement occurs such as in the neck, under the arms, and in the folds of the elbows and knees. When the skin is picked up between the finger and the thumb, it can be stretched excessively. Striae or numerous flat papules are usually present. They may be discreet or confluent. The patient as a rule is free of complaints. The superficial epithelial layers of the skin become atrophied and the histopathologic picture reveals an extensive degeneration of the elastic fibers in the midcorium. No changes in the glands of the skin and in the hair follicles are noted.

Sandbacka and Holstrom[12] accumulated 100 cases extending over a period from 1929-1939, 87 of which demonstrated angioid streaks.

Angioid streaks in association with Paget's disease was first described by Rowland[13] in 1929. Paget's disease or osteitis deformans was first described by Paget in 1877. He believed this to be a condition of chronic inflammation of the flat bones with secondary excessive overgrowth. The long bones of the lower extremity may show marked deformity and the skull in particular may be markedly enlarged with much thickening of its outer plate and its floor especially in the region of the sella turcica.

Terry,[14] in 1934, reported on nine cases of Paget's disease in association with angioid streaks. Two additional cases were added by Lambert[15] in 1939. The relationship of Paget's disease to angioid streaks is not clearly understood. No case has been reported of any individual having Paget's disease and pseudoxanthoma elasticum at the same time.

As early as 1896, deSchweinitz[16] observed the high incidence of systemic vascular disease in patients showing angioid streaks. Holloway[17] noted generalized circulatory disturbance in 23.3 percent of 60 cases he collected from the literature. Bock[18] in 1939 and later Hagedoorn[19] demonstrated that there was a degeneration of elastic tissue fibers of the smaller arteries and the aorta.

Scheie and Freeman,[20] in 1946, reported on three cases of angioid streaks which revealed rather marked pathologic changes of the peripheral vessels. They recorded an almost complete absence of peripheral pulsations and calcification of the vessels of the lower extremities which were later proven by X-ray studies. Microscopic study of a portion of a diseased ulnar artery showed degeneration of the elastic tissue in the media with narrowing of its lumen. They concluded that there probably existed a generalized process of degeneration of elastic tissue fibers in certain body structures which was responsible for the vessel changes, the angioid streaks, and the pseudoxanthoma elasticum.

Walsh and Murray[21] observed angioid streaks and pseudoxanthoma elasticum in two patients who had suffered from repeated gastric hemorrhages. Calcification of the arteries in the extremities and vascular hypertension in pseudoxanthoma elasticum has been described by Revell and Carey.[22]

Comment

Progressive macular changes become of paramount importance in the presence of angioid streaks. The late picture may be indistinguishable from senile disciform macular degeneration.

Duke-Elder[23] reported on 150 cases, of which 53 percent showed some kind of macular involvement.

Scholz[24] in 1941, in a most comprehensive series of 188 cases, reported varying macular changes in 140. He emphasized that the early macular changes are characterized by the presence of edema, some type of exudate, or hemorrhage. As the disease progresses, the macular hemorrhages become more pronounced and are later replaced by connective tissue bands and clumps of dark pigment deposits.

Fleischer in 1938, reporting on Oler's patient, stated that the vision remained unaffected for a period of 23 years, but later the macula became markedly involved and

vision finally dropped to counting fingers.

Coppez and Dannis,[25] in 1925, followed a patient for over a period of 25 years. It was after a period of eight years that this patient presented marked bilateral macular degeneration.

Conclusion

A case of a man, 43 years of age, with angioid streaks and pseudoxanthoma elasticum which were observed and recorded by fundus photography over a period of 27 years, is reported because of the marked progressive macular changes that eventually followed. The final picture was indistinguishable from that of a typical senile macular disciform degeneration.

It seems to be the opinion of most writers that the entity called "angioid streaks" exemplifies a syndrome with selective affinity for the elastic tissue of various body structures. The particular structures involved are Bruch's membrane of the choroid, the skin, and particularly the peripheral vessels of the extremities. The diagnosis of angioid streaks is arrived at by a typical ophthalmoscopic picture. Prior to this examination, if a patient presents an abnormally large skull, a lemon color discoloration of the skin, or the complaint of frequent cramplike pains in the lower extremities, the ophthalmologist should consider the possible presence of this condition. It appears very likely that a patient with angioid streaks, living for a sufficiently long period of time, will eventually develop marked and progressive bilateral macular destructive changes.

160 Henry Street (1).

I wish to thank Dr. Wendell L. Hughes for permitting me to reproduce Figure 1, which appeared in his article in the *Archives of Ophthalmology*, May, 1929.

References

1. Doyne, R. W.: Tr. Ophth. Soc. U. Kingdom, **9**:128, 1889.
2. Knapp, H.: Arch. Ophth., **21**:289, 1892.
3. Hughes, W. L.: Arch. Ophth., **1**:551 (May) 1929.
4. Kofler, A.: Arch. f. Augenh., **82**:134, 1917.
5. Verhoeff, F. H.: Tr. Sec. Ophth. A.M.A., 1928, p. 242.
6. Klien, B. A.: Am. J. Ophth., **30**:955, 1947.
7. Cowper, A. R.: Arch. Ophth., **51**:762, 1954.
8. Hallopeau and Laffitte: Ann. dermat. & syph., **4**:595, 1903.
9. Groenblad, E.: Acta Ophth., **7**:329, 1929.
10. Balzer, F.: Arch. physiol. norm. & path., **4**:65, 1884.
11. Darier, J.: Monatsschr. prakt. Dermat., **20**:609, 1896.
12. Sandbacka-Holstrom, I.: Forh. nord. dermat. Foren., 1939, p. 648. Abstracted: Zentralbl. ges. Ophth., **44**:701, 1940.
13. Rowland, W. D.: Am. J. Ophth., **16**:61, 1933.
14. Terry, T. L.: Tr. Am. Ophth. Soc., **32**:555, 1934.
15. Lambert: Arch. Ophth., **22**:106, 1939.
16. deSchweinitz, G. E.: Tr. Am. Ophth. Soc., **32**:650, 1896.
17. Holloway, T. B.: Tr. Am. Ophth. Soc., **25**:173, 1927.
18. Bock, J.: Ztschr. Augenh., **95**:1, 1938.
19. Hagedoorn, A.: Arch. Ophth., **21**:746 (May); **21**:935 (June) 1939.
20. Scheie, H. G., and Freeman, N. E.: Arch. Ophth., **35**:241, 1946.
21. Walsh, F. B., and Murray, R. G.: Am. J. Ophth., **36**:1657, 1953.
22. Revell, S. T. R., and Carey, T. N.: Southern M. J., **41**:782, 1948.
23. Duke-Elder, W. S.: Textbook of Ophthalmology, St. Louis, Mosby, 1941, v. 3, pp. 2413-2418.
24. Scholz, R. O.: Arch. Ophth., **26**:677, 1941.
25. Coppez, H., and Dannis, M.: Arch. Ophth., **42**:649, 1925.

A QUANTITATIVE TEST FOR DETERMINING THE VISIBILITY OF THE HAIDINGER BRUSHES: CLINICAL APPLICATIONS*

LOUISE L. SLOAN, PH.D., AND HOWARD A. NAQUIN, M.D.
Baltimore, Maryland

In plane (or moderately elliptical) polarized light the normal eye can see an entoptic pattern consisting of two tufts which radiate in opposite directions from the fixation point. The phenomenon was first described by Haidinger in a series of articles published between 1844 and 1854.[1] He used the term "Polarizationsbüschel"; in English the double tufts are commonly referred to as Haidinger's brushes. The phenomenon depends entirely upon regional variations in the brightness of the blue component of the incident light. The pattern is therefore most easily seen in such light where it appears as a dark figure on a blue background. In white light the two brushes are yellow. The fact that the intervening spaces appear bluish rather than white has generally been attributed to contrast.

The various theories advanced to explain the phenomenon have recently been reviewed in detail by Stanworth and Naylor.[2] The most widely accepted explanation is based on the suggestion of Helmholtz[3] that radially oriented fibers in the macula are dichroic and absorb blue light to a greater degree when its vibrations are perpendicular to the direction of the fiber. Helmholtz suggested that the yellow pigment of the macula could be the blue absorbing substance. This view is supported by the fact that the brushes occupy a central field subtending four to five degrees, corresponding closely to the extent of the pigmented area.

Stanworth and Naylor advanced a new theory that the structures which function as an analyzer of the incident plane polarized light are the blue receptors themselves, which could also be dichroic and oriented radially in the macula. Less than average absorption of the blue component would account for the yellow brushes seen in white light. The intervening sectors would appear bluish because of a greater absorption of blue light than in more peripheral areas where the receptors are assumed to be randomly oriented.

Like other entoptic phenomena, the brush pattern fades rapidly if a fixed region of the retina is stimulated. Boehm[4] showed that, if the pattern is caused to rotate by a continuous rotation of the polarizer, practically all normal eyes can see the dark brushes formed in blue light. Boehm also studied the effects of introducing between the eye and the source of plane polarized blue light retardation plates of various thicknesses.

Optical theory indicates that a birefringent plate producing a retardation of approximately half the wavelength of the blue light (half-wave plate) should reverse the direction of rotation of the brushes. With a quarter-wave plate the brushes should oscillate between two positions at right angles to one another. Although a half-wave plate did produce a reversal of rotation as predicted, the effects produced by quarter- and eighth-wave plates did not correspond exactly to the expected results and varied with the location of the plate's axis in relation to the eye. To explain these findings Boehm postulated that the cornea itself produced in some way a retardation of about 50 mμ, that is, about one-eighth of 400 mμ.

Stanworth and Naylor's direct measurements[5] of the polarization optics of the isolated cornea showed that its effective birefringence is extremely small for light incident normally but increases rapidly with increasing obliquity. Owing to the angle between the fixation and the optic axes the

* From the Wilmer Ophthalmological Institute of The Johns Hopkins University and Hospital. This study was carried out under Contract Nonr-248(24) between The Johns Hopkins University and the Office of Naval Research.

normal cornea could have a slight effect on the polarization of the light reaching the fovea, such as that observed by Boehm.

The only published investigations of the effects of ocular disease on ability to perceive the Haidinger brushes are those of Goldschmidt,[6] Forster,[7] and Schmidt.[8]

Goldschmidt devised a simple instrument known under the trade name of Macula Deficiency Tester. His conclusions as to the clinical value of his test may be summarized as follows:

1. The brushes are recognized by 100 percent of persons possessing normal maculas and of average mental capacity.

2. All kinds of ocular anomalies and diseases in which there is involvement of the macula can be detected at an early stage.

3. In cases of unilateral strabismus and amblyopia ability to see the brushes is an indication that vision can be improved by occlusion of the other eye.

4. The test provides a means of differentiating between diseases of the macula and of the optic nerve. In support of this Goldschmidt says "It has been established that Haidinger's brushes are seen in cases of optic nerve atrophy in which central vision was not less than 20/60."

Forster's findings were essentially similar to those reported by Goldschmidt. Information was not given by either author as to the number of eyes examined.

Schmidt investigated the diagnostic value of the test in glaucoma. Of the 14 glaucomatous eyes studied, eight saw the brushes. The six who did not included one amblyopic eye and two with nuclear sclerosis of the lens. Schmidt infers from her findings that disappearance of the brush pattern is apparently linked with a primary or a secondary affection of the macula.

Instrument and procedure used in present investigation

The source of light used in our instrument is a 100-watt Sylvania superwhite lamp. Because of its heavily frosted coating this lamp provides a uniform field of high luminance. The second component of the instrument is a blue-violet filter: Corning No. 5113, thickness three mm. This filter transmits practically no light of wavelengths greater than 490 mμ. The third component is a disc of No. 328 Polaroid film which is rotated at 60 revolutions per minute by means of a clock motor.* The fourth is a half-wave plate which, when introduced between the eye and the violet test field, reverses the direction of rotation of the entoptic pattern. A sheet of ordinary cellophane was found adequate to produce the desired reversal of rotation of the pattern seen in violet light. The fifth component is a circular disc containing a series of neutral gelatine filters which can be interposed in turn between the eye and the test field, in order to decrease its luminance. The six luminances of violet light provided in this manner are approximately 2, 1, 0.5, 0.25, 0.125, and 0.06 millilamberts.

Test scores ranging from 0 to 6 were assigned to indicate the lowest luminance at which the direction of rotation of the brushes could be reported correctly. A score of 0 for example means that either the brushes were not seen at all at a luminance of 2.0 ml. or, if faintly seen, the direction of rotation was reported incorrectly; a score of 1 means that correct responses were given at level 1 but not at level 2, and so forth. The score indicating the lowest luminance at which the brushes are perceived is hereafter designated as the HB score.

Since it is well established that an uncorrected error of refraction has no effect on ability to perceive the entoptically formed brush pattern, the subjects as a rule did not wear their glasses while taking the test.†

* Since, within wide limits the speed of rotation has no effect on the visibility of the pattern, manual rotation of the disc can be substituted for the electric motor.

† Contact, aniseikonic, shatterproof, and so forth, lenses of plastic should not be worn by the patient while taking the brush test because the

Results

HB scores of normal eyes

Of 136 normal eyes, 85 (62.5 percent) made scores of 6, and 47 (34.5 percent) scores of 5. HB scores of 3 and 4 were observed in four instances (three percent). Two of these were scores obtained by children of eight and 11 years of age. Except for the possibility of poor comprehension, we have no explanation to offer for the relatively poor brush scores observed in a few apparently normal eyes.

Two other subjects showing no evidence of any ocular disease were unable to perceive the pattern with either eye at the highest intensity, thus making HB scores of zero. Their marked deviation from normal suggests some congenital anomaly of the macula, not apparent to ophthalmoscopic examination. These two markedly atypical cases were therefore omitted from the normal group and are discussed in further detail in a later section with data for other subjects having various congenital ocular defects.

On the basis of the distribution of the HB scores of normal eyes, scores of 4 or less may be considered as almost certainly indicative of some ocular abnormality.

HB scores in various forms of eye disease

To investigate the possible clinical applications of a measurement of the visibility of the Haidinger brushes, patients with the following eye defects were studied: (a) macular lesions, (b) optic neuropathies, (c) pigmentary degeneration of the retina, (d) glaucoma, (e) amblyopia ex anopsia, (f) abnormalities of the ocular media including cataract and keratoconus, (g) various congenital anomalies. In reporting the data, the same eye is occasionally represented more than once if tests on two or more occasions showed different findings because of progress or regression of the disease.

A. *Macular lesions*

Table 1 shows the relationship between corrected visual acuity and HB scores of 99 eyes with various forms of retinal lesion involving the macular area. These included central serous retinitis, chorioretinitis, neuroretinitis, diabetic and hypertensive retinitis, choroiditis, retinal atrophy, macular cyst, macular hemorrhage, and so forth.

Of the 99 eyes in this group, 82 made subnormal HB scores. The data indicate some degree of relationship between corrected visual acuity and HB score. All those with acuities of 20/100 or less had scores of zero. All 23 eyes with acuities of 20/50 to 20/80 had subnormal HB scores. In the group with acuities from 20/20− to 20/40, 31 of 39 or approximately 80 percent failed. Of those with acuities of 20/20 or better, 17 of 26 or 65 percent failed the brush test in spite of their relatively good acuities.

Of the 17 with normal HB scores, eight had acuities less than 20/20. Further information about this group is given in Table 2. Analysis of their field defects reveals that the scotomatas were paracentral, very small, or, if pericentral, of low density. This is illustrated in Figure 1 which shows the scotomas of the two eyes with the lowest acuities, namely 20/40 and 20/30.

In one case the defect covered the entire area, four to five degrees in diameter, in which the brushes appear; it was however "relative" only for a 2/330 blue test object.*

In the second case there was a small ab-

plastic material may be birefringent. Its effect on the apparent direction of rotation of the brushes varies with the thickness and with the orientation of the plastic material. In one trial set of plastic contact lenses, for example, some lenses produced oscillation of the brush pattern (quarter-wave retardation), others a reversal of rotation (half-wave retardation), and some had no effect (full-wave retardation).

* In this paper the scotoma mapped with a specific size of red or blue test object is designated as "absolute" for that test object when its color is not perceived at all; as "relative" when its color is reported as dimmer or weaker than in surrounding areas.

TABLE 1

RELATIONSHIP BETWEEN HB SCORES AND CORRECTED VISUAL ACUITY IN 99 EYES WITH MACULAR LESIONS

Acuity	HB Score						
	0	1	2	3	4	5–6	Total
20/100 or less	11	0	0	0	0	0	11
20/80 to 20/50	20	0	1	2	0	0	23
20/40 to 20/20–	16	3	5	3	4	8	39
20/20 or better	2	2	3	5	5	9	26
Total	49	5	9	10	9	17	99

solute scotoma for a blue test object covering only a portion of the "brush area." It is apparent that the test may fail to detect a macular lesion associated with a slightly subnormal acuity if a considerable portion of the macular area is spared or if the defect, when more extensive, is of low density.

The HB scores may, on the other hand, be subnormal when visual acuity is 20/20 or better and the macula shows to ophthalmoscopic examination only minimal evidence of abnormality. Table 1 shows that of 26 eyes with some form of macular lesion and acuity of 20/20 or better, 17 or 65 percent had subnormal scores. Further data on these 17 eyes are given in Table 3. In several instances the central scotomas were relative only for a 2/330 blue test object. In other cases they were absolute for 3/330 or 6/330 blue.

B. *Optic neuropathies involving the central field of vision*

This group comprised 50 eyes with optic neuropathies such as toxic amblyopia, optic neuritis, retrobulbar neuritis, primary and secondary optic atrophy, and defects of unknown etiology producing either bitemporal or homonynous field defects.

Table 4 gives the relationship between corrected acuities and HB scores for these 50 eyes. As was true for the group with macular lesions, all those with acuities of 20/100 or poorer had scores of zero. Of the eight eyes with acuities of 20/20 or better only two had subnormal HB scores. These occurred in the two eyes of a patient with a right homonymous field defect following a cerebral vascular accident.

In the group with macular lesions, it will be recalled, 65 percent of the eyes with

TABLE 2

MACULAR LESIONS AND REDUCED ACUITY ASSOCIATED WITH NORMAL HB SCORES

Subject	Acuity	Comments
M. E.	20/20 – 2	Drusen at macula. No demonstrable central scotoma
G. D.	20/22 (metamorphopsia)	Parafoveal cyst. Paracentral relative scotoma for 2/330 blue
S. H. right eye S. H. left eye	20/25 – 3 20/25 – 3	Retinal atrophy O.U. No data on central fields
A. P. right eye A. P. left eye	20/20 – 20/20 –	Questionable macular degeneration, O.U. Relative central scotoma for 2/330 blue, O.U.
H. C.	20/30	Retinal atrophy and choroidal sclerosis. Relative central scotoma for 2/330 blue. See Fig. 1
W. G.	20/40	Subhyaloid hemorrhage in macular region. Small absolute central scotoma for 2/330 blue. See Fig. 1

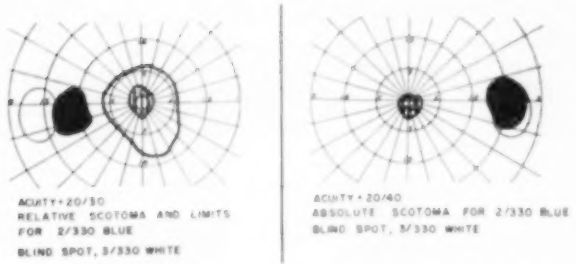


Fig. 1 (Sloan and Naquin). Central scotomas of two eyes with macular lesions and subnormal acuities in association with normal HB scores.

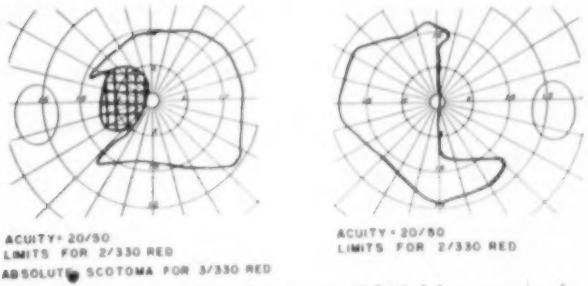


Fig. 2 (Sloan and Naquin). Bitemporal field defects associated with normal HB scores.

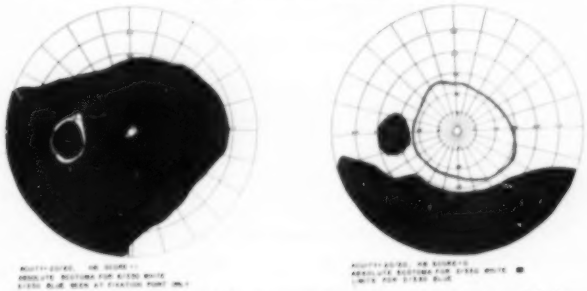


Fig. 3 (Sloan and Naquin). Central fields of two patients with low brush scores in association with normal acuities.

acuities of 20/20 or better had subnormal HB scores. Seven eyes with subnormal acuity associated with some form of optic neuropathy had normal HB scores. Additional information pertaining to these seven is given in Table 5. The data on the central field defects indicate that normal HB scores were probably achieved because in no case did the field defect involve the entire area in which the brushes appear. This is illustrated in Figure 2, which shows the bitemporal defects of a patient whose acuity was reduced to 20/50 in each eye.

C. *Comparison of results in macular lesions and in lesions of the optic pathway*

Subnormal HB scores were obtained in 74 percent of eyes in which the central field defects were caused by lesions posterior to the retinal level. These included 27 eyes with acuities of 20/50 or poorer and 10 eyes with acuities of 20/40 or better. Our data therefore do not support Goldschmidt's view that the brush test is of value in the differential diagnosis of diseases of the macula and of the optic nerve. Our findings, on the other hand, do suggest that impairment of visual function at the retinal level produces a somewhat greater loss in visibility of the entoptic brush pattern than does equally severe impairment resulting from a lesion in the optic pathway. Possible factors responsible for this differential effect are considered in a later section.

D. *Pigmentary degeneration of the retina and allied conditions*

Scores on the brush test were determined for a group of 27 eyes, 23 of which showed typical pigmentary degeneration of the retina. Of the other four, two had retinitis punctata albescens, and two had retinal atrophy, ring scotomas, and night blindness. Opacities of the lens or vitreous, of minor degree, were noted in six cases; in all others the ocular media were clear.

In Table 6, showing the relation between corrected visual acuities and HB scores for

TABLE 3

MACULAR LESIONS AND NORMAL ACUITY ASSOCIATED WITH SUBNORMAL HB SCORES

Subject	Acuity	HB Score	Comments
F. S.	20/13	0	Central serous retinitis. Absolute central scotoma for 6/330 blue
V. M.	20/20	1	Central serous retinitis. Relative central scotoma for 3/330 blue
J. C.	20/20	2	Central serous retinitis. Relative central scotoma for 2/330 blue
A. McG.	20/15	4	Central serous retinitis. No central scotoma demonstrable with 2/330 blue
J. L. 11/ 3/52	20/15 – 2	2	Central serous retinitis. Relative central scotoma for 2/330 blue
11/ 5/52	—	3	Visual fields not tested
11/19/52	20/15 – 1	4	Visual fields not tested. Macular edema has almost disappeared
L. B. right eye	"Normal"	4	Drusen in both maculae. No central scotoma demonstrable in either field with 3/330 blue
L. B. left eye	"Normal"	3	
M. T. right eye	20/15 – 1	2	Chorioretinitis O.U. Rt. macula appears normal.
M. T. left eye	20/20 + 2	0	Pigment deposits in left macula
H. M.	20/15 – 4	3	Drusen in macula, thinning of retina. Doubtful recognition of 2/330 blue
M. K.	20/15 –	3	Macular chorioretinitis. A 2/330 blue test object appears green in central field
C. S.	20/15	3	Questionable senile macular degeneration. Absolute central scotoma for 2/330 blue, relative central scotoma for 3/330 blue
M. W. right eye	20/17	4	Retinal atrophy, O.U. following neuroretinitis. No
M. W. left eye	20/17	1	central or paracentral field defect found in right eye. Paracentral defect for 3/330 white, left eye
B. K.	20/20	4	Chorioretinitis. Absolute scotoma for 6/330 blue, temporal to fixation point

this group, it may be seen that 18 of the 27 had scores of 0 or 1. Of particular interest are the three instances of such low brush scores in association with acuities of 20/20 or better. Detailed study of the central fields were made for two of these three eyes, and are shown in Figure 3.

In one case the inability to see the brushes is explained by the presence of a ring scotoma for 6/330 white which came within two

TABLE 4

RELATIONSHIP BETWEEN HB SCORES AND CORRECTED VISUAL ACUITY IN 50 EYES WITH VARIOUS FORMS OF OPTIC NEUROPATHY

Acuity	HB Score						
	0	1	2	3	4	5–6	
20/100 or less	17	0	0	0	0	0	17
20/80 to 20/50	7	1	1	1	0	2	12
20/40 to 20/20 –	3	0	0	3	2	5	13
20/20 or better	0	0	0	1	1	6	8
	27	1	1	5	3	13	50

TABLE 5

POSTRETINAL LESIONS AND REDUCED ACUITY ASSOCIATED WITH NORMAL HB SCORES

Subject	Acuity	Comments
P. D. right eye P. D. left eye	20/50 20/40	Bitemporal field defects of undetermined etiology for 3/330 and 2/330 red. See Fig. 2
L. F.	20/40	Optic atrophy of undetermined etiology. Absolute field defect for 1/330 red involving only a part of macular field
T. G.	20/40	Optic atrophy secondary to previous optic neuritis. Paracentral absolute scotoma for 3/330 red
J. H.	20/25+2	Optic atrophy. Has had operation for removal of pituitary tumor. Central field studies not made
W. S.	20/20−4	Optic atrophy secondary to previous optic neuritis. Temporal field defect, absolute for 2/330 red, extending to fixation point
V. Y.	20/20−1	Prechiasmal glioma has been removed. Absolute paracentral field defect for 1/330 red

degrees of the fixation point. In the second case, however, a 2/330 blue test object was seen as blue in a central field extending 10 degrees or more from the fixation point. In this instance impairment of visual function in the central field, though revealed by the brush test, was not demonstrable either by perimetric examination or by determination of the visual acuity.

Two eyes had normal HB scores in association with slightly subnormal acuities of 20/25 and 20/20 − 1. The minor lens opacities present in the first case were probably responsible for the reduced acuity since a 1/330 blue test object was seen in the central field. In the second case, a nine-year-old child, the slightly subnormal acuity of 20/20 − 1 is perhaps of no significance.

Our data indicate that in pigmentary degeneration of the retina the brush test provides a quick and sensitive means for determining whether or not the degenerative process is beginning to impair perception in the central field of vision.

TABLE 6

RELATIONSHIP BETWEEN HB SCORES AND CORRECTED VISUAL ACUITY IN 26 EYES WITH PIGMENTARY DEGENERATION OF THE RETINA OR ALLIED CONDITION

Acuity	HB Score					
	0	1	2	3-4	5-6	
20/100 or less	3	0	0	0	0	3
20/80 to 20/50	5	3	0	1	0	9
20/40 to 20/20−	3	1	0	0	2	6
20/20 or better	1	2	0	1	4	8
	12	6	0	2	6	26

E. *Glaucoma*

An extensive study of the effects of glaucoma on ability to see the brushes was not considered of much value for the following reasons:

First, the very small pupil associated with the use of pilocarpine reduces the effective luminance of the test field, and might in itself result in a subnormal brush score on our test.

Secondly, the typical Bjerrum scotoma, even when well advanced, may spare completely the central area of the visual field, so that normal HB scores could occur even in patients with advanced glaucoma.

A selected group of 10 eyes with glaucoma were studied, because they had reduced visual acuity or field defects suggesting an impairment of visual perception in the central as well as in paracentral areas. The four eyes with corrected acuities of 20/100 or poorer all had HB scores of zero.

TABLE 7

RELATIONSHIP BETWEEN HB SCORES AND CORRECTED VISUAL ACUITY IN 10 EYES WITH GLAUCOMA

Acuity	HB Scores			
	0–1	2–4	5–6	
20/100 or less	4	0	0	4
20/80 to 20/50	0	0	0	0
20/40 to 20/20−	1	2	0	3
20/20 or better	1	2	0	3
	6	4	0	10

Three with corrected acuities of 20/40, 20/40, and 20/30 had subnormal scores of 0, 2, and 3, respectively. Three with acuities of 20/20 or better had subnormal scores of 1, 3, and 3. Figure 4 shows the central fields of the patient with a score of 1 and a visual acuity of 20/15 − 3. Red test objects (6/330 and 3/330) were not seen in a considerable portion of the central field, although the fovea itself was spared.

We have no data on the size of the pupils of any of these patients at the time the HB scores were obtained. It is possible therefore that a small pupil rather than the glaucoma itself was responsible for the subnormal HB scores of some or all of this group.

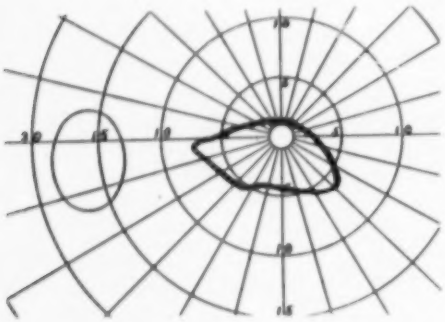


Fig. 4 (Sloan and Naquin). Central field of a glaucomatous eye with a low brush score in association with normal acuity.

F. Review of findings in 190 eyes with various forms of ocular disease

In our series of 190 eyes with macular lesions, pigmentary degeneration of the retina, glaucoma, or optic neuropathy, the HB scores were zero without exception in every instance in which the corrected acuity was 20/100 or poorer, regardless of whether the lesion responsible was located at the retinal level or somewhere in the optic pathway.

In those with visual acuities better than 20/100, the HB score was more closely related to the location and density of the field defect than to the type of ocular disease. When the scotoma was of low density or involved only a part of the central area in which the brushes appear, some patients with subnormal visual acuity nevertheless achieved normal HB scores. Central field defects sparing a portion of this area probably occur more frequently when the lesion is posterior to the retinal level than when there is macular disease. For this reason alone perception of the brushes is likely to show greater impairment in macular than in postretinal lesions with equal impairment of visual acuity.

Another possible factor is the well-known fact that retinal lesions may produce a greater impairment in sensitivity to blue stimuli than do postretinal defects. Since ability to see the brushes of our test requires detection of a dark gray pattern on a blue background, a greater impairment of the blue receptors in retinal disease than in optic neuropathy could play a role in the differential effect of the two types of lesion on the HB scores.

A third possible factor which might play a part in impairing visibility of the brushes is that either the radial arrangement of the Henle fibers or their dichroic properties could be directly disturbed by a central serous retinitis or an active chorioretinitis. This possibility is suggested by the very low HB scores found in some instances in association with good acuity and only minimal evi-

TABLE 8

RELATIONSHIP BETWEEN HB SCORES AND CORRECTED ACUITY IN 33 EYES WITH AMBLYOPIA EX ANOPSIA

Acuity	HB Scores				
	0	1–2	3–4	5–6	
20/100 or less	6	0	1	5	12
20/70 to 20/50	0	0	0	9	9
20/40 to 20/20−	0	0	0	12	12
	6	0	1	26	33

dence of macular disease on ophthalmoscopic and perimetric examination (table 3).

G. *Amblyopia ex anopsia*

Our studies of eyes with organic ocular lesions have indicated that the size of the central scotoma is an important factor in determining whether or not the brushes are seen. In amblyopia associated with squint or with anisometropia a central scotoma can sometimes be demonstrated in monocular vision. It may be quite dense but is usually small in comparison with the central scotomas characteristic of most organic lesions. A study of the effects of such amblyopias on the HB scores is therefore of interest.

Table 8 shows the relationship between acuities and HB scores for 33 eyes whose subnormal vision was associated with squint, high anisometropia, or a combination of these two factors. The results differ from those observed in eyes with organic disease in that normal scores were found without exception in all those with acuities of 20/70 or better and in five of the 12 with acuities of 20/100 or poorer. Of the 12 eyes with acuities of 20/100 or poorer six had scores of 0 and five had normal scores on the brush test.

A possible explanation for the two quite different types of response was suggested by additional studies of two adults in this group:

A small absolute central scotoma for 6/330 white (fig. 5) was demonstrable in monocular vision in the amblyopic eye of one subject whose HB score was zero. On repetition of the brush test he noticed for the first time a small portion of the pattern outside the central area and was then able to report correctly the direction of its rotation even at the lowest level of luminance. His HB score therefore changed from 0 to 6 when a remnant of the brush pattern was detected outside the limits of his very dense central scotoma.

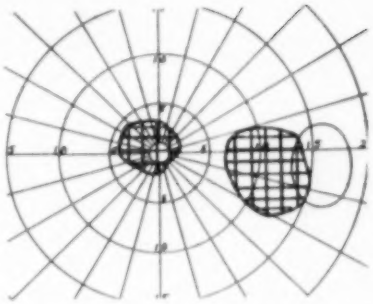


Fig. 5 (Sloan and Naquin). Central scotoma in an amblyopic eye with HB score of zero.

Similar tests were given to another adult whose vision in the amblyopic eye was 20/100 but who nevertheless saw the brush pattern at the lowest intensity. In this case no central scotoma could be detected with a 3/330 blue test object. Other tests showed questionable evidence of slightly eccentric and somewhat unsteady fixation suggesting that a very small central scotoma could have been present which escaped detection because of shifts in fixation. Because a majority of the patients with amblyopic eyes were children, similar tests for central scotomas were not attempted in other cases.

It seems possible that those with acuities of 20/100 or poorer who achieved normal HB scores had central scotomas of sufficient density to reduce foveal vision but not large enough to obscure the entire brush pattern. The nearest approach to this situation observed in eyes with organic lesions is the one case reported in Table 2. This

patient had a subhyaloid hemorrhage at the macula reducing vision to 20/40. Presumably because of the small size of the central scotoma he was able to achieve a normal HB score.

It seems possible therefore that in so far as their effects on the HB scores are concerned, the most important difference between an organic lesion and amblyopia ex anopsia is that the former as a rule involves the entire field in which the brushes appear, whereas the latter in many instances involves only the central portion of this area. We have made no studies to evaluate Goldschmidt's claim that inability to see the brushes in amblyopia ex anopsia offers a poor prognosis for improvement following occlusion of the unaffected eye. The degree of impairment of visual acuity is generally considered to give some indication of the improvement to be expected. If, however, Goldschmidt's views are correct the prognosis may depend not only upon the density of the scotoma but also upon the size. Inability to see the brush pattern suggests that the scotoma is larger than is usually found in amblyopia ex anopsia.

H. *Cataracts and keratoconus*

Since a dense cataract will absorb or diffuse a considerable portion of the blue light which serves as the stimulus for the brush pattern, and since the diffusion may produce partial depolarization of the light, some reduction of the HB score might be expected in cataractous eyes. Table 9 gives data on the corrected visual acuities and HB scores of 11 eyes showing various stages of opacity of the lens.

TABLE 9

RELATIONSHIP BETWEEN HB SCORES AND CORRECTED VISUAL ACUITY IN 11 EYES WITH CATARACT

Vision	HB Scores				
	0	1-2	3-5	5-6	
20/100 or less	0	0	2	1	3
20/70 to 20/50	1	0	1	2	4
20/40 to 20/20 –	1	1	1	1	4
	2	1	4	4	11

It is apparent that the effect on the HB scores cannot be predicted from the visual acuity. In one case for example a cataract reducing acuity to 20/100 was associated with a score of 5; another patient had immature senile cataracts in each eye, normal maculas, acuities of 20/50 and 20/40, and HB scores of 0 in each eye. If the HB score is normal in an eye with a cataract and low vision, it is highly probably that there is no pathologic involvement of the central field. On the other hand a low HB score in a cataractous eye with low vision provides no reliable information as to the integrity of function of the central visual field, since either the cataract itself or some retinal or optic nerve lesion could be responsible for the subnormal brush score.

The findings in two patients with binocular keratoconus indicate that this condition also can impair visibility of the brushes:

Case M. B. showed a marked thinning and a central opacity of the right cornea. The left cornea was clear and showed only a slight degree of thinning. The discs, vessels, and macular regions were of normal appearance. The HB scores were 0, right; 6, left.

Case L. F. showed in both eyes moderate thinning at the center of each cornea and a few vertical tears in Descemets' membrane, slightly more marked in the right eye. In both eyes the dioptric powers in the vertical meridian were too high to measure on the keratometer, that is, greater than 52 diopters. The discs, maculas, and vessels were normal. The HB scores were 4, right; and 5, left.

Since the brush pattern is formed entoptically, it cannot be influenced by poor imagery associated with the high and irregular errors of refraction associated with keratoconus. The most likely explanation is that the incident light is partially depolarized in some way as it passes through the cornea. The studies of Stanworth and Naylor on the polarization optics of the normal cornea

suggest that in keratoconus the obliquity of incidence of the light resulting from the conical shape, and perhaps other effects connected with stretching of the corneal surface, could partially depolarize the incident light and so reduce the visibility of the brush pattern.

1. *Congenital ocular anomalies*

This group includes subjects with congenital nightblindness, achromatopsia, protanopia, deuteranopia, tritanopia, and several cases in which there was evidence of a minor congenital anomaly of the macular structure.

Two subjects with congenital nightblindness were studied:

Case G. Complete absence of rod function was established by numerous tests[9] including determination of the dark-adaptation curve of a paracentral region of the retina. With correction of a high hyperopia and astigmatism his visual acuity was 20/40 in each eye. He was unable with either eye to see any trace of the brush pattern at the highest intensity.

Case B. G. The second congenital nightblind subject had an amblyopic left eye associated with a convergent squint. The right eye showed no evidence of ocular disease and had a corrected acuity of 20/25. Both she and her sister have been aware of night blindness from early childhood. The parents are first cousins. As in the previous case the adaptation curve showed complete absence of the rod section. With the right eye the direction of rotation of the brush pattern was detected with difficulty at level 2. At levels 1 and 2 she perceived only a central dark spot with a very small revolving projection. This projection was seen continuously on the right side of her fixation point, but on the left side it was seen for only an instant when it reached the horizontal position. Since no scotoma was demonstrable in the central field to account for this partial loss of the entoptic pattern it is probably the result of some anomalous arrangement of the retinal structures responsible for the pattern.

Four subjects with congenital achromatopsia had HB scores of zero. Detailed studies of three (B. McC., D. T., and L. G.) have been reported in a previous paper.[10] Findings on various tests indicate that L. G. has an incomplete form of achromatopsia. His visual acuity was 20/50 in the right eye, 20/30 in the left. Ophthalmoscopic examination revealed an absence of the normal foveal reflexes but no other abnormality. The other three subjects were typical achromats with visual acuities of about 20/200 in each eye.*

Boehm studied three typical achromats, none of whom could see the Haidinger brushes. Since they could see actual drawings closely resembling the brush pattern, he concluded that poor visual discrimination was not directly responsible for their inability to perceive the entoptically formed pattern. Ophthalmoscopic examination of their maculas in red-free light showed no trace of the normal yellow coloration. Boehm suggested therefore that absence of the yellow macular pigment was responsible for the failure of these subjects to perceive the brushes.

Subjects with typical protanopia and typical deuteranopia made normal HB scores. The one available subject with tritanopia also made a normal score of 5. Analysis of the data based on determinations of the confusion colors of this tritanope indicates that the bluish field of our brush test is for her almost but not quite a chromaticity match to a neutral gray stimulus. Since her spectral luminosity curve is within normal limits it is probable that for her the difference in brightness between the brush pattern and the rest of the central field is the same as that perceived by the normal eye. It may be assumed therefore that the brush pattern

* Another achromat with zero HB scores recently examined was of the rare type sometimes referred to as "cone Monochromatism." The visual acuity of each eye was 20/10 and the fundi were normal.

was distinguished primarily because it was darker than the surrounding areas.

If tritanopia is interpreted as a simple absence of blue receptors then our findings are not compatible with the Stanworth and Naylor theory that the brushes are formed by the blue receptors. If on the other hand the pattern is produced by localized differences in absorption of blue light by a yellow pigment filter, then the brushes could be perceived by a tritanope as a dark pattern on a light background even if there were no marked differences in color.

Three other subjects with zero brush scores and no evidence of ocular disease are included here because of other evidence suggesting possible congenital abnormalities of the maculas:

Case C. F. had seven diopters of hyperopia in each eye. With correction of his refractive error his vision was 20/70 in each eye. On ophthalmoscopic examination the macular regions showed absence of the normal foveal reflex but no other abnormality. An absolute central scotoma for 1/330 blue was found in each eye.

Case H. A. B. had compound myopic astigmatism corrected by −4.25D. sph. ⊂ −1.00D. cyl. ax. 180°, right eye; −3.25D. sph. ⊂ −1.0D. cyl. ax. 120°, left eye. With this correction his acuity was 20/20 + right, 20/15 left. Both macular regions were somewhat abnormal in appearance. The foveal reflexes were absent, and the blood vessels extended further than normal toward the foveas. Absolute scotomas were demonstrable in each eye with a 1/330 blue test object. In the right eye the scotoma was about five degrees in diameter, in the left eye only about two degrees in diameter. Although on the first examination he saw no brush pattern whatever at the highest intensity, on repetition of the test at a later date he saw a faint spot moving in a circle which became elongated as it passed through the lower right quadrant of the field.

Case M. S. This subject had 20/15 vision in each eye with correction of a low degree of myopic astigmatism. Ophthalmoscopic examination revealed no abnormality other than a greater than normal encroachment of the blood vessels onto the macular area, similar to that observed in the previous case. No central field defects were demonstrable with a 1/330 blue test object. A complete absence of even the faintest trace of the brush pattern was confirmed in repeated tests.

A test for ability to see the entoptic Maxwell spot was given to H. A. B. and to M. S. This test consisted of alternation of a neutral and a reddish-blue filter before the eye while viewing a white surface illuminated either by Standard Illuminant A or by Illuminant C. Most normal observers see through the colored filter a reddish spot on a blue background with Illuminant A, a dark and faintly reddish spot with Illuminant C. Subjects H. A. B. and M. S. were not able to see any pattern in either of these illuminations.

In our experience the Maxwell spot is not as easily seen by normal eyes as are the Haidinger brushes. Nevertheless the failure of both subjects to see either of these entoptic phenomena strongly suggests that the same visual mechanism may be responsible for both, and that the difference in the two entoptic patterns is caused by the use of unpolarized light in one case, plane polarized light in the other. The Maxwell spot is attributed by most investigators to absorption of the blue component of the light by yellow macular pigment. Walls, on the other hand, believes it is caused by a nonuniform distribution of the blue receptors in the central retina. The Haidinger brushes similarly are considered by a majority to depend upon the differential absorption of polarized light by a yellow macular pigment, whereas Stanworth and Naylor believe that the blue receptors are responsible.

Our findings in this group of subjects suggest that some developmental anomaly which interferes with formation of the Haidinger brushes can occur by itself or in

association with either of two quite different hereditary defects affecting respectively the cone and the rod mechanism. Since these congenital anomalies are extremely rare, the subnormal HB scores associated with them should not interfere with the possible usefulness of the brush test in detecting ocular disease and in following its progress.

Summary and Conclusions

The visibility of the Haidinger brushes was determined for 136 normal eyes, and for 241 eyes with ocular disease, amblyopia ex anopsia, or congenital anomaly.

1. The HB scores were subnormal in the great majority of the eyes having macular disease. Low scores were also noted in eyes with various forms of optic neuropathy, but only if visual perception was impaired in a major portion of the central field in which the brushes would normally appear.

2. In high degrees of amblyopia ex anopsia with vision of 20/100 or less, the HB scores were normal in some instances, markedly reduced in others. The ability of the amblyopic eye to perceive the brush pattern probably depends primarily upon the extent of the central area in which function is depressed in monocular vision.

3. Subnormal brush scores were sometimes noted as a result of a cataract or an advanced keratoconus. The reduction in visibility of the entoptic pattern by such defects of the ocular media is probably the result of scattering, absorption, and partial depolarization of the incident light.

4. Seven subjects whose eyes were apparently free of any form of ocular disease saw either no brush pattern whatsoever or a very incomplete form of the normal pattern. Other findings suggest that some congenital anomaly of the macular structures was responsible for the absence of the normal entoptic pattern.

5. Because of the many different causes of subnormal HB scores, the test is of only limited value in differential diagnosis. A markedly subnormal brush score in association with a minimal field defect is however strongly suggestive of a macular rather than an optic nerve lesion. Central serous retinitis in particular can be associated with an obviously subnormal HB score at a stage at which the condition could easily be overlooked on routine examination. In a cataractous eye with low vision, a normal HB score can be considered as reliable evidence of an intact macula.

6. The chief merits of this new test as a supplement to standard procedures are (a) it is rapid and simple, (b) it is not influenced by uncorrected ametropia, and (c) it gives reliable results in patients whose unsteady fixation interferes with detection of a central field defect.

The Johns Hopkins Hospital (5).

We are indebted to Adelaide Habel for technical assistance in this study.

References

1. Haidinger, W.: (a) Ueber das direkte Erkennen des polarisierten Lichts. Ann. d. Phys. u. Chem., **63**:29, 1844; (b) Ueber komplimentare Farbeneindrucke bei Beobachtung der Lichtpolarisationsbüschel. Ibid., **67**:435, 1846; (c) Beobachtung der Lichtpolarisationsbüschel in geradlinig polarisiertem Licht. Ibid., **68**:73, 1846; (d) Beobachtung der Lichtpolarisationsbüschel auf Flachen, welche das Licht in zwei senkrecht aufeinander sebenden Richtungen polarisierten. Ibid., **68**:305, 1846; (e) Das Interferenzschachbrettmuster und die Farbe der Polarisationsbüschel. Ibid., **85**:350, 1850; (f) Dauer des Eindrucks der Polarisationsbüschel auf der Netzhaut. Ibid., **93**:318, 1854; (g) Beitrag zur Erklärung der Farben der Polarisationsbüschel durch Beugung. Ibid., **91**:291, 1854; (h) Einige neuere Ansichten uber die Natur der Polarisationsbüschel. Ibid., **96**:314, 1854.

2. Stanworth, A., and Naylor, E. J.: Haidinger's brushes and the retinal receptors with a note on the Stiles-Crawford effect. Brit. J. Ophth., **34**:282 (May) 1950.

3. von Helmholtz, H.: Treatise on Physiological Optics. (Translated by J. P. C. Southall.) Ithaca, N.Y., Optical Society of America, 1924, vol. 2, p. 304.

4. Boehm, G.: Ueber maculaire (Haidinger 'sche). Polarisationsbüschel und über einen Polarisationsoptischen Fehler des Auges. Acta Ophth., **18**:109, 1940.

5. Stanworth, A., and Naylor, E. J.: (a) The polarization optics of the isolated cornea. Brit. J. Ophth., **34**:201 (Apr.) 1950; (b) Polarized light studies of the cornea: I. The isolated cornea. J. Exper. Biol., **30**:160, 1953.

6. Goldschmidt, M.: A new test for the function of the macula lutea. Arch. Ophth., **44**:129 (July) 1950.

7. Forster, H. W., Jr.: The clinical use of the Haidinger's brushes phenomenon. Am. J. Ophth., **38**:661 (Nov.) 1954.

8. Schmidt, I.: Diagnostic value of foveal entoptic phenomena in glaucoma. Arch. Ophth., **52**:583, 1954.

9. Riggs, L. A.: Electroretinography in cases of night blindness. Am. J. Ophth., **38**:70 (July, Part II) 1954.

10. Sloan, L. L.: Congenital achromatopsia: A report of 19 cases. J. Optical Soc. Am., **44**:117 (Feb.) 1954.

THE USE OF SULFIRGAMIDE IN EXTERNAL DISEASES OF THE EYES

FREDERICK H. THEODORE, M.D.
New York

With the advent of the many excellent antibacterial agents now at our disposal, the emphasis on the treatment of infections of the outer eyes has shifted, in most instances, from the acute to the more chronic varieties. In fact, nowadays, the ophthalmologist, himself, encounters relatively few acute infections except those of viral origin, as the ones due to bacteria are usually treated successfully by the general physician or the pediatrician, and are, anyway, mostly self-limited. Thus the ophthalmologist's major concern in this field is with the more difficult chronic type of infection, where dramatic results are the exception rather than the rule, and where successful management requires both careful diagnosis and judicious choice of medicaments.

In this regard at the present time, major reliance is generally placed on topically applied antibiotics or sulfonamides. The introduction of the antibiotics for a time tended to overshadow this latter group. However, after a period of relative disfavor, with the development of newer types of sulfonamides, this group of drugs has again become popular because of certain practical advantages. These include:

(1). Satisfactory effectiveness against almost all bacteria commonly causing external ocular infections, as well as the intermediate group of viruses (chlamydozoaceae) causing trachoma, inclusion conjunctivitis, and lymphopathia venereum; (2) stability in solution; (3) high solubility; and (4) economy.

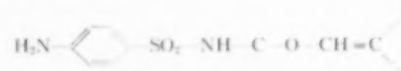
Their major drawbacks, shared with the antibiotics, are:

(1). The development of bacterial resistance; and (2) allergic reactions as well as, in certain instances, irritation. Even the newer sulfonamides commercially available in this country, valuable as they are, exhibit these tendencies.

It was therefore felt worthwhile to investigate the clinical effectiveness of another sulfonamide, Sulfirgamide, which had never been used in this country, but which on the basis of older European reports, appeared to show some promise.

BACKGROUND AND BASIC PROPERTIES OF SULFIRGAMIDE

Shortly after the clinical introduction of sulfanilamide, about 15 years ago, numerous other sulfonamides were investigated in search of a better drug. One of these, Sulfirgamide (n-dimethyl acroyl-sulfanilamide)



showed a very favorable toxic-to-therapeutic ratio in animals[1] and was clinically effective in man in a variety of systemic diseases.[2,3] Although the allergic type of reac-

Sulfirgamide was supplied by Geigy Pharmaceuticals, Division of Geigy Corporation, New York, through the courtesy of Dr. Albert Hemming.

tions such as drug rash did not occur,[3] the availability of other effective sulfonamides for systemic use, and the local effectiveness and excellent tolerance of Sulfirgamide, led to an emphasis of its topical use. Since the sodium salt of Sulfirgamide is quite soluble and can be prepared as a nonirritating eye drop in effective concentration at a reasonable pH (8.2), it appeared to be worthy of trial as a locally effective treatment of eye infections without danger of sensitization by prior systemic use.

Sulfirgamide is a tasteless white crystalline powder with a molecular weight of 254. Its sodium salt is very soluble and stable in aqueous solution. A 20-per cent solution of the sodium salt has a pH of 8.4. Its in vitro bacteriologic spectrum resembles that of other sulfonamides. Although these investigations did not demonstrate any superiority of Sulfirgamide over other sulfonamides,[1, 4, 5] the in vivo animal studies showed it to be as good as, or better than, the other sulfonamides tested, in its action against pneumococci and hemolytic streptococci.[1]

Sulfirgamide is used in Europe as a 15-percent ointment. Favorable results in ophthalmology were reported by Schmid and Saubermann,[6] Bangerter,[7] and Vogelsang.[8] My clinical studies include this form of the drug as well as a four-percent and 7.5-percent (isotonic) aqueous solution of its sodium salt. The repeated daily application of Sulfirgamide solution into the rabbit eye for over three weeks produced no evidence of irritation.[4]

Clinical results

Sulfirgamide was used in over 300 patients. In about 200 persons it was used in treatment of infections; in the other 100 it was used prophylactically, both pre- and postoperatively, and following corneal foreign bodies and corneal abrasions. In 83 patients only the 15-percent ointment was used, one to four times daily; in all the other patients, sterile aqueous solutions, at first four percent, later 7.5 percent, were utilized as eye-drops, three to five times daily. The ointment was used in this latter group only at night or not at all. No preservatives was used in the solutions, for the dual purpose of eliminating two possibilities: (1) that beneficial results might be due to such antiseptics rather than the Sulfirgamide, and (2) that any drug allergy resulting from such preservatives might be wrongly attributed to the drug under investigation. The use of Sulfirgamide in these forms was in general well accepted, and the incidence of irritation and allergy proved to be very low.

The drug was tried on all the usual types of external conditions encountered in routine ophthalmic practice. As the evaluation of clinical results is at best difficult and of little worth unless exact etiologic diagnoses are made, bacteriologic studies were carried out whenever possible. These included differential cultures, secretion smears, and epithelial scrapings of the conjunctiva and lid margins. Staphylococci were studied for the coagulase reaction, hemolysis, and the fermentation of mannitol. No attempt was made to select favorable patients; actually many patients on which it was tried had failed to respond to other therapy and had been referred for consultation. It was used in all cases where sulfonamide therapy might be indicated. It was withheld only in those patients where a history of sulfonamide allergy was elicited.

Acute conjunctivitis

Table 1 indicates the results with the use of Sulfirgamide in the acute varieties of conjunctivitis. As was to be expected in those patients with diagnostically definite acute bacterial conjunctivitis, use of the drug resulted in marked improvement within a few days in almost every case. In the 29 patients with mucopurulent conjunctivitis of undetermined etiology, the results were good, but in general not as marked or as rapid. In some of these patients the disease was relatively mild, so that changes were less striking.

In general, Sulfirgamide was not used in

TABLE 1

CLINICAL RESULTS IN TREATMENT OF ACUTE CONJUNCTIVITIS WITH SULFIRGAMIDE

Type of Conjunctivitis	Total No. Cases	Improvement			
		Marked	Satisfactory	None	Results Not Known
Acute Bacterial					
Staphylococcus (toxigenic)	14	11	3	—	—
Pneumococcus	4	4	—	—	—
Staphylococcus & Pneumococcus	1	1	—	—	—
H. Koch-Weeks	1	1	—	—	—
H. influenzae	2	2	—	—	—
No culture or sterile culture	29	9	12	1	7
Acute Viral					
Beal type	1	—	—	1	—
Epidemic keratoconjunctivitis	1	—	—	1	—
Inclusion conjunctivitis	2	2	—	—	—
Trachoma (old, but active)	1	—	1	—	—

either acute follicular conjunctivitis (Beal type) or in epidemic keratoconjunctivitis because it was believed not to be indicated. The drug was used inadvertently in one case of each type with negative results.

In inclusion conjunctivitis, Sulfirgamide was used in two patients with what was felt to be spectactular results. This had been anticipated to some extent because of the fact that the drug is a derivative of sulfanilamide, considered by many the most effective systemic sulfonamide for this purpose.

In the first patient, an infant with inclusion blenorrhea, the use of the ointment alone, six times a day, resulted in marked improvement in one day and the disappearance of all inflammatory signs and intracellular inclusions in 48 hours.

The other patient, an adult, was a very instructive case. The rather severe conjunctivitis had first been treated with aureomycin, but because improvement had not been satisfactory, cortisone had been substituted with further aggravation of the condition. When seen in consultation seven weeks after onset, inclusion bodies were still easily demonstrated. Treatment with four-percent Sulfirgamide eyedrops every two hours and the 15-percent ointment at night resulted in the disappearance of inclusions in two days, accompanied by marked clinical improvement which continued uninterruptedly until all inflammatory signs were completely gone, in about 10 days. Resorption of follicles, as usual, took much longer.

CHRONIC CONJUNCTIVITIS

As could be expected, 28 cases of chronic catarrhal conjunctivitis with a definite staphylococcal etiology, not associated with significant blepharitis, did fairly with Sulfirgamide, especially at the beginning (table 2). Later in some cases relapses occurred and therapy with other antibacterial agents, including silver nitrate, was used. In other patients the use of staphylococcus toxoid was resorted to along with treatment with Sulfirgamide for periods up to four months.

In one patient with bilateral chronic conjunctivitis due to Pseudomonas aeruginosa (B. pyocyaneus), Sulfirgamide gave negative results. The use of chloromycetin, neomycin, and polymixin, as indicated by bacterial sensitivity tests, was only partially effective. Complete clearing followed the prolonged use of 10-percent sodium propionate.[9]

Of 11 cases of chronic conjunctivitis where cultures were negative, significant improvement occurred in six, none in three; two patients did not return for follow-up. In 42 patients where no culture was taken, better results were noted, probably because this group was the mildest to start with. About half of these patients did not return,

TABLE 2

CLINICAL RESULTS IN TREATMENT OF CHRONIC CONJUNCTIVITIS WITH SULFIRGAMIDE

Etiologic Factor	Total No. Cases	Improvement			
		Marked	Satisfactory	None	Results Not Known
Staphylococcus (toxigenic)	28	8	13	2	5
Staphylococcal allergy	3	—	1	2	—
Pseudomonas aeruginosa (B. pyocyaneus)	1	—	—	1	—
Negative culture	11	1	5	3	2
No culture	42	—	19	4	19

and thus could not be evaluated, possibly because they needed no further treatment.

CHRONIC INFECTIONS OF THE LID

Treatment of chronic lid infections such as blepharoconjunctivitis, as noted above, is often not simple. The use of a drug by the patient alone will not always suffice in a severe case. The condition generally requires considerable local treatment by the ophthalmologist, as well as injections of toxoid or vaccine, should it recur. Often, local medicaments soon lose their effect after initial improvement.

In this series all cases studied revealed toxigenic staphylococci on culture (table 3) and responded well to Sulfirgamide. While the drug seemed to become less effective in some cases, its continued use along with other treatment was useful. In two very severe cases where circumstances did not allow any treatment except the use of the 15-percent ointment, really dramatic improvement accompanied by essentially negative cultures was noted in follow-ups, in one instance of six months, in the other of one year. These patients continue to use the ointment of their own volition, although they appear to be well.

Seven patients with staphylococcal eczema of the eyelids were studied; four secondary to blepharitis. Several were of the greatest severity. All showed marked initial improvement with Sulfirgamide; some needed other forms of antistaphylococcal therapy later on. As pointed out in other papers[10, 11] this very recalcitrant form of dermatitis normally does not respond quickly to local medicaments but

TABLE 3

CLINICAL RESULTS IN TREATMENT OF CHRONIC INFECTIONS OF THE LID WITH SULFIRGAMIDE

	Total No. Cases	Improvement			
		Marked	Satisfactory	None	Results Not Known
Blepharoconjunctivitis					
Staphylococcus (toxigenic)	29	12	11	—	6
Mixed (Staph. and yeast)	3	—	1	—	2
Staphylococcal eczema					
With blepharitis	4	4	—	—	—
Without blepharitis	3	3	—	—	—
Meiboconjunctivitis					
Staphylococcus (toxigenic)	20	7	8	2	3
Negative culture	2	—	2	—	—
Lid infection (Staph.)	2	1	1	—	—
Chalazion (acute)	13	5	7	—	1
Styes (recurrent)	4	2	2	—	—

requires careful and prolonged treatment. The over-all response to Sulfirgamide was at least as good as with other antibacterial agents, and in some instances better when one considers the frequency of bacterial resistance and drug sensitivity in this particular disease.

Another related type of infection, perhaps even more difficult to eradicate, is meibomitis associated with conjunctivitis. Sulfirgamide proved definitely useful in the cases studied in this series. However, it is felt that reliance on other forms of therapy including expression of the meibomian glands is more important in this persistent condition than any local medicament.

Similarly, the best treatment of acute chalazia is, again, expression. All one can expect of locally applied medicaments is a clearing of the associated conjunctivitis. This Sulfirgamide did in a satisfactory manner.

The use of the drug in acute hordeolum and as a possible preventive in some cases of recurrent styes was satisfactory. In two instances of staphylococcal lid infections good results were also obtained.

Corneal infections

Sulfirgamide was effectual in the treatment of five relatively mild corneal infections of staphylococcal etiology. Two patients had superficial keratitis; the other three had marginal keratitis. In this latter group it was thought that the infiltrates, although themselves sterile, were toxic manifestations secondary to staphylococcal infection of the eyelids and conjunctiva.

In a patient with a central corneal ulcer of pneumococcal etiology, occurring following the breakdown of an old corneal opacity, who was treated with Sulfirgamide, improvement was noted in 24 hours, and was marked by 48 hours.

The drug was ineffectual in two patients with punctate keratitis of viral etiology. One of these was a case of epidemic keratoconjunctivitis.

In a patient with a history of recurrent herpes simplex keratitis, typical dendritic lesions occurred while Sulfirgamide was being used successfully for the treatment of staphylococcal conjunctivitis.

Miscellaneous conditions

Two patients with chronic dacryocystitis were treated with Sulfirgamide solution. In one case the contents of the sac became much clearer; in the other it was ineffectual.

Two patients with psoriatic conjunctivitis received Sulfirgamide. In the one with secondary infection, improvement was marked; in the other no improvement was noted.

A fairly large group of patients received the drugs prophylactically, as stated above, with no untoward results.

Allergy

One instance of mild, but definite, allergic dermatoconjunctivitis from Sulfirgamide ointment was encountered. Two other patients reported redness and increased inflammation following prolonged use of the drops, but did not develop the typical eczematous reaction characteristic of allergy. It is more probable that an irritative, rather than an allergic, reaction occurred in these patients.[12]

Conclusions

Trial in over 300 patients indicates that Sulfirgamide is of definite value in the topical treatment of infections of the outer eye. Its major indications are acute bacterial conjunctivitis, inclusion conjunctivitis, and chronic infections of the eyelids, such as blepharitis, meibomitis, and conjunctivitis, especially of staphylococcal origin.

In general, like other sulfonamides, its results in acute infections were very good. In some instances, the response was not as striking as that noted from the use of antibiotics, when these are effectual. On the other hand, instances of superiority to previously tried antibiotics were also encountered. In chronic infections its effectiveness and limitations were found to be about the same as the antibiotics now available, and its

use offers another valuable means of treatment.

Compared to several other sulfonamides now in general use, its value in bacterial infections, as far as can be determined, is about equal. However, its outstanding effectiveness in two cases of inclusion conjunctivitis suggests that it is superior to them, as well as tetracycline antibiotics, in infections due to chlamydozoaceae and that the drug deserves adequate trial in the treatment of trachoma.

Unfortunately, like every other medicament so far available for ophthalmic use, except possibly iodine, Sulfirgamide is of no value in the treatment of infections due to other types of viruses. Like other sulfonamides, it is not recommended for central corneal ulcers, especially those due to Pseudomonas aeruginosa, where specific antibiotics are the drugs of choice.

The relatively low incidence of allergy and irritation as compared to other sulfonamides and antibiotics is a point in favor of its use in all infections for which it is indicated. In prophylactic treatment of ocular injuries, it appears to be valuable as well as safe, and, clinically, does not seem to delay healing.

667 Madison Avenue (21).

References

1. Högger, D.: Irgamid, eine neue Verbindung der Sulfanilamidreihe. Schweiz. med. Wchnschr., **71**:31, 901-904, 1941.
2. Markoff, N.: Die Behandlung akuter Infektious Krankheiten mit Irgamid (G290). Schweiz. med. Wchnschr., **71**:31, 904-907, 1941.
3. Scherer, H.: Unsere Erfahrungen mit Irgamid (G290) in Geburtshilfe und Gynäkologie. Schweiz. med. Wchnschr., **71**:31, 907-908, 1941.
4. Bliss, E. A., and Deitz, H. D.: A comparison of the bacteriostatic activities of some of the newer sulfonamide compounds. Bull. Johns Hopkins Hosp., **75**:1-13 (July) 1944.
5. Morgan, A.: Washington Institute of Experimental Medicine, personal communication.
6. Schmid, A. E., and Saubermann, G. B. C.: Die Sulfanilamidtherapie in der Augenheilkunde mit Irgamid. Ophthalmologica, **103**:65-80, 1942.
7. Bangerter, A.: Erfahrungen mit Irgamid-Augensalbe. Praxis, **31**:565-567, 1942.
8. Vogelsang, K.: Ueber Augensalben und deren Anwendung, Klin. Monatsbl. f. Augenh., **120**:2, 154-163, 1952.
9. Theodore, F. H.: Use of sodium propionate in external infections of the eyes. J.A.M.A., **143**:226-228 (May 20) 1950.
10. ———: Differentiation and treatment of eczemas of the eyelids. Tr. Am. Acad. Ophth., **58**:708-723 (Sept.-Oct.) 1954.
11. ———: Staphylococcal eczema. Acta XVII International Congress (to be published).
12. ———: Drug sensitivities and irritations of the conjunctiva, J.A.M.A., **151**:25-30 (Jan. 3) 1953.

Ophthalmic Miniature

Thirdly, in extracting the Chrystalin, we should be careful to give a sufficient Dilatation, to its Capsula, least it should happen to us, as it did, to an eminent Surgeon in London, about two years ago; who in performing this Operation, on a poor Man, in the Hay Market, by pressing hard on the Ball of the Eye, before the Chrystalin Bag, was sufficiently (if at all) opened, forced out both vitreous Humour, and Chrystalin.

Critical analysis of the new operation for a cataract,
Mr. O'Halloran of Limerick. 1750.

ADVISING PATIENTS WITH HEREDITARY EYE DISEASE*

P. Thomas Manchester, Jr., M.D.
Atlanta, Georgia

Hereditary features have been reported in connection with every part of the eye. Even such conditions as dacryocystitis and recurrent corneal erosion are familial in isolated instances. Although most of these familial characteristics are only of academic interest, there are several serious conditions which are frequently familial, and it is particularly important for them to be understood. Merely to recognize a hereditary disease is certainly not enough. One must diagnose the type of inheritance and make predictions for the patient's offspring as well as other members of his family.

Abnormal genes affecting the eye make their presence known by producing either dominant, recessive, or sex-linked recessive traits. Often the word "autosomal" is used to characterize those traits which appear freely in both men and women alike, without being affected by the sex of the individual.

Every abnormality must begin somewhere, and patients may appear with a disease which they are going to transmit to many generations in the future, although their family history is completely negative. These patients are living mutants, and the defective gene first appears in them.†

Dominant traits

Dominant traits are always obvious. That is, if a person carries the gene for a simple dominant feature, then he must show the feature be it glaucoma, cataract or aniridia. If a particular disease is inherited as a dominant trait, there will be many affected individuals in the family tree. Approximately 50 percent of the members in each generation should show the abnormality.

When confronted with a patient whose eye malady is inherited as a dominant trait, one can make predictions with reasonable accuracy for future offspring (see tables 1 and 2):

1. If the patient is young, his parents may wish to know the likelihood of this disease appearing in their future children. They can be told with reasonable accuracy that the next child will have a 50-percent chance of developing the disease.

2. As for the patient himself, assuming that he will marry a normal person, 50 percent of his future children will be affected.

3. The normal members of this family, such as brothers, sisters, aunts, and uncles, cannot be carrying the dominant gene and need not fear the possibility of having affected children. Only in irregular circumstances can anyone transmit a dominant gene

TABLE 1

How to determine the mode of inheritance

Dominant
1. One of the parents is affected
2. Fifty percent of the members are affected
3. Normal members have all normal children

Recessive
1. Neither parent is affected
2. The parents are usually related (consanguineous union)
3. Twenty-five percent of the siblings are affected
4. Affected members have normal children*
5. Normal members have normal children*

Sex-linked recessive
1. Affects only men
2. Transmitted via the normal women
3. Affected men have normal children*
4. Normal women have 25 percent of their children affected (i.e., 50 percent of the males, no females)

* Normal here means the phenotype. The individual may still be a carrier but will not have the disease.

* From the Department of Ophthalmology, Emory University School of Medicine, and the Grady Clay Memorial Eye Clinic, Grady Memorial Hospital, Atlanta, Georgia.

† It is thought that all hereditary traits originate as mutations, which are the result of alterations within the complex amino-acid molecules composing the genes in the reproductive cells. These alterations may take place in the normal parents as a result of trauma, radiation, biochemical effects, or reduction division.

TABLE 2

WHAT ARE THE CHANCES MY NEXT CHILD WILL DEVELOP THE DISEASE?

Type of Heredity	Person Asking Question			
	Parents of the Patient	The Patient	Normal Aunts & Uncles	Affected Aunts & Uncles
Dominant	50%	50%	0	50%
Recessive	25%	0	0	0
Sex-linked recessive	(50% of sons) (none of daughters) 25%	0	Women 25% or less Men 0	Affected uncles may transmit but will have normal children.

without himself giving evidence that this particular gene lies in his own germ plasm.

Sometimes there will occur the confusing feature of glaucoma being transmitted by a person with seemingly normal eyes. This is an instance of what is called "irregular dominance." It may represent an effect of environment upon hereditary, that is, perhaps the patient has lived a protected life free from emotional trauma, and this has allowed him the privilege of normal eyes although he does have a tendency to glaucoma. Certainly one cannot accept the report from relatives that any member has normal eyes if the rules of heredity direct that he should have the disease. Even after examination with negative provocative tests, this individual may later acquire true glaucoma. One practical value in recognizing hereditary glaucoma lies in the fact that seemingly normal members of such a family must be followed very carefully.

Figure 1 characterizes the typical family tree for the dominant trait glaucoma. It is evident that affected members transmit the disease to approximately half of their offspring and unaffected members never transmit the trait. The first affected member at the head of the family tree, of course, acquired the defect from his normal parents because of a mutation.

Retinoblastoma is a dominant trait which merits some discussion. Usually children with retinoblastoma are brought to the ophthalmologist by parents who have perfectly normal eyes.

First consider the parents. Could either of them possess the gene for retinoblastoma? Since the gene is a dominant one and neither parent has the disease, it can be assumed

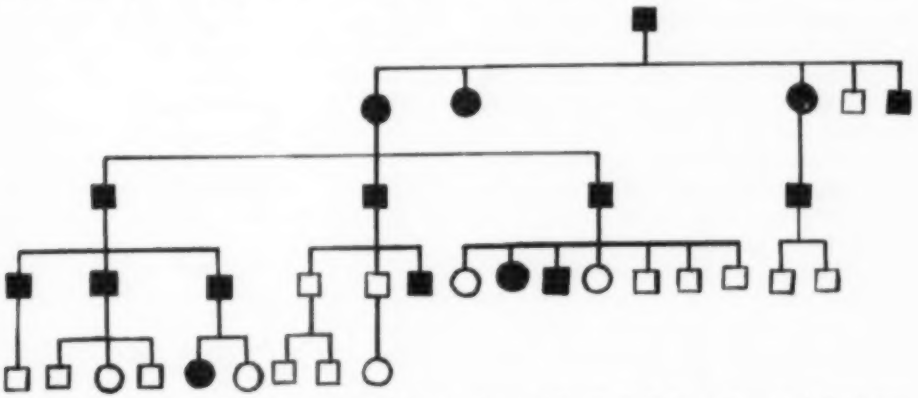


Fig. 1 (Manchester). Dominant glaucoma. All are patients of Dr. F. P. Calhoun. Squares indicate men, circles indicate women. Affected individuals are in black.

that they do not carry the gene and their affected child must represent an example of mutation. Their other children should be normal, since neither of these parents is a carrier of retinoblastoma.

How often do these parents ask the ophthalmologist: "May we have another child? And if we do, how likely are we to relive the same tragedy again with a second child similarly marked by retinoblastoma?"

Theoretically, they have no chance of bringing forth another child with retinoblastoma because they do not possess the abnormal gene. This statement should be made with a slight reservation, as there may be some unknown environmental or cellular factor which produced the one deformed child and by the same physical or chemical action it might cause a second mutation. Actually in the literature, 595 sporadic cases of retinoblastoma have been studied.[1] Of these, only seven siblings developed retinoblastoma. Consequently, the parents should be informed that the chances of their next child having retinoblastoma are about one in a hundred.

The patient himself presents an entirely different genetic problem if he survives the retinoblastoma. He has manifested this dominant disease, and obviously his germ plasm does possess the trait. Should he have children? The answer is emphatically no. Theoretically each of his offspring will have a 50-50 chance of getting retinoblastoma. Actually, of those cases which are on record, the incidence is even higher than has been calculated.

The responsibility of the ophthalmologist goes beyond diagnosing and treating the retinoblastoma. Parents of the patient should be advised to have more children, as this may be a great consolation to them, since their next child should be normal. On the other hand, anyone who has survived a retinoblastoma must be forbidden to have offspring because the odds are so great against their ever escaping the disease.[2, 3]

Cataracts of many types have been known to show a dominant hereditary tendency. However, most cases of cataract are merely sporadic and are not in any way hereditary. On the contrary, other dominant traits such as aniridia, blue sclerotics, phakomatoses, arachnodactyly, and retinoblastoma are practically always hereditary and, therefore their genetic features must be given careful consideration routinely.[4–12]

Recessive traits

Recessive traits are the hidden ones. It has been calculated that each of us possesses the gene for at least one important physical defect which we do not show because it is recessive. When two people marry both of whom happen to transmit the same hidden trait, the offspring may then actually show the defect. Thus a "double dose" is necessary for recessive genes to produce any effect on a child. Since members of the same family are more likely to have the same hidden genes, recessive traits usually appear when relatives marry (consanguinous union, fig. 2). It has been suggested that this may explain why incest has always been taboo, even in primitive tribes.

Advice to patients with the problem of a recessive disease should differ considerably from that given to patients with a dominant one. Even though both parents may carry a recessive trait, the chances are only 1:4 that their next child will get a gene from

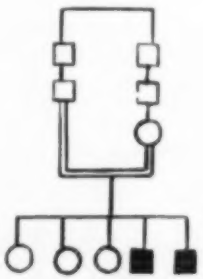


Fig. 2 (Manchester). Recessive Laurence-Moon-Biedl syndrome. Patients of Dr. F. P. Calhoun. Double lines indicate consanguinity.

each parent and manifest the disease. As for the patient himself, if his mate is normal, he will not transmit the abnormality to any of his children. All of them must be normal. They may be carriers, of course, but they will never develop the disease because they receive only one gene from their affected parent and one from his normal mate. A defective gene must come from each parent before the disease itself will be apparent.

Pure albinism is an example of a recessive trait. If normal parents appear with an albino child, inquiry should be made regarding consanguinity because this is such a frequent explanation for the appearance of recessive traits. These parents might want to know the chances that their next child will be likewise affected with albinism. The answer is 1:4. A second question which may be posed is the likelihood of this first albino child having affected children when he marries. It is interesting that all of his children must be normal, unless, by chance, he marries another albino or someone with the hidden trait. This, of course, would be extremely unlikely. If the aunts, uncles, and other unaffected members of this family ask about the chances of their children being albinos, they can be assured that without consanguinity the chances are almost nil (table 2).

Sex-linked traits

Sex-linked traits are peculiar in one respect, from the standpoint of ophthalmology. They are transmitted by both sexes but they affect only the men.* In other words, though men are the only ones who suffer from these inherited traits, actually the women with normal eyes bear much of the responsibility of carrying them on to the next generation.

It is not difficult to give sound advice regarding sex-linked traits. The parents should be informed that half their sons may get the disease, but none of their daughters will, even though they may be carriers. The patient himself, being an affected male, will never have any children with the disease.

His daughters may be carriers, perhaps, but their eyes will be normal just the same. Of course, it is vitally important for the patient to know the odds of having affected children; whereas, it is only of academic or eugenic importance for him to appreciate the far-reaching problems of normal children who may be carriers. The important thing for him to realize is that his children will never have the disease.

If the patient has a brother whose eyes are normal, this brother will not transmit the disease. In contrast, the normal sisters and normal daughters will likely give it to 50 percent of their sons.

Figure 3 is the family tree of a 22-year-old patient with choroideremia, a sex-linked trait. It is evident that only males are affected and the disease was contracted via the asymptomatic carrier mother. However, as happens to be the case with choroideremia, this mother had fine pigment dots in her optic fundi even though her vision and fields were normal. In this way, it was possible to identify the seemingly normal mother as one who might transmit choroideremia.

Comments

The ocular diseases discussed so far are usually inherited in only one way; thus, glaucoma and cataracts are practically always inherited as dominant traits and very rarely demonstrate recessive or sex-linked characteristics. Once the malady has been diagnosed, one can make predictions and advise the patient, even if there is no detailed

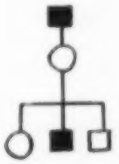


Fig. 3 (Manchester). Sex-linked recessive choroideremia.

*There are no significant eye diseases inherited specifically as sex-linked affecting women.

family tree. There is another group of important diseases which may be transmitted by either of these three methods either dominant, recessive or sex-linked recessive. For these, two or three generations must be plotted before one can decide which type of inheritance he is dealing with.

Laymen often ask about the heredity of refractive errors, color blindness, and eye color. Obviously these are academic questions, but still their frequent repetition stimulates the search for a ready answer. Consistently accurate predictions cannot be made about refractive errors. Because ametropia depends upon the corneal curvature, anterior chamber depth, and refractive index of the lens as well as the axial length of the eye, it is impossible to fathom the mechanisms involved in this kind of inheritance. In general, the small refractive errors show dominant characteristics, and the larger refractive errors show recessive characteristics. The common forms of color blindness (Daltonism) have a sex-linked recessive pattern. There are three pairs of genes controlling eye color and, therefore, this condition is unpredictable although, in general, brown is dominant over blue.

One vital omission may be apparent by this time. No consideration has been given to those situations in which a mating occurs between a man and a woman, both of whom are affected by the same ocular disease. For example, consider a marriage between a man who has survived after treatment for retinoblastoma and a woman who has likewise been treated for retinoblastoma, or the case of a man and wife who are both nearly blind from pigmentary degeneration of the retina. Such unhappy circumstances are possible but extremely unlikely. These would be rare situations with most complicated possibilities for any offspring. Of course, most ophthalmologists are never confronted with such a problem in their every-day practice.

A list of the important eye diseases has been compiled and classified (table 3). There are exceptions to the classification of course. Nearly all of them, including cataract, glaucoma, and macular dystrophy, may appear sporadically without any hereditary features. Thus it would be ridiculous to advise any glaucoma patient that his descendents are likely to transmit this trait unless there is evidence that preceding generations have been affected.

TABLE 3

CLASSIFICATION OF THE IMPORTANT HEREDITARY EYE DISEASES

DOMINANT
- Concomitant strabismus
- Duane's syndrome
- Ptosis with epicanthus
- Phakomatoses
- Blue sclerotic syndrome
- Cataracts (congenital and postnatal)
- Retinoblastoma
- Glaucoma
- Dacryocystitis
- Arachnodactyly
- Corneal dystrophy of granular type and lattice type
- Aniridia
- Recurrent corneal erosion
- Heterochromia congenita
- Dominant optic atrophy of children

RECESSIVE
- Pure albinism
- Microphakia
- Amaurotic family idiocy
- Laurence-Moon-Biedl syndrome
- Hydrophthalmos
- Corneal dystrophy—macular type

SEX-LINKED
- Choroideremia
- Red-green colorblindness
- Megalocornea
- Lebers' hereditary optic atrophy*

DISEASES WITH UNPREDICTABLE MODES OF INHERITANCE
- Cerebromacular degeneration
- Macular dystrophy
- Congenital absence of rods
- Congenital absence of cones
- Keratoconus—usually alternating with high astigmatism
- Craniofacial anomalies
- Hereditary ataxias
- Elastosis dystrophica—Groenblad-Strandberg syndrome—pseudoxanthoma elasticum
- Nystagmus
- Pigmentary degeneration of retina
- Progressive external ophthalmoplegia
- Gyrate atrophy
- Fuchs' epithelial-endothelial dystrophy

* This should be considered sex-linked recessive in advising patients, although there are rare instances of affected females. Another unusual feature is the fact that for some reason affected males do not transmit to any future generations.

Table 2 considers facts which may be given the patient and his relatives in answer to their question of how likely are their children to develop the disease. No consideration whatever has been given to the problem of how many unaffected children may be carriers. This is a matter of eugenic importance and, being outside the scope of ophthalmology, is best left to the opinion of specialists in that field.

178 Peachtree Street, N.E. (3).

References

1. Reese, A. B.: Tumors of the eye. New York, Hoeber, 1951.
2. ———: Frequency of retinoblastoma in the progeny of parents who have survived the disease. Arch. Ophth., **52**:815-819 (Dec.) 1954.
3. ———: Heredity and retinoblastoma. Arch. Ophth., **42**:119-122 (Aug.) 1949.
4. Probert, L. A.: A survey of hereditary glaucoma. Canad. M. A. J., **66**:563-568 (June) 1952.
5. Frey, W. G., and Posner, A.: Familial glaucoma. Arch. Ophth., **47**:454-458 (Apr.) 1952.
6. Calhoun, F. P.: Hereditary glaucoma (simplex). J.A.M.A., **63**:209 (July) 1914.
7. Walsh, F. B.: Clinical Neuro-Ophthalmology. Baltimore, Williams & Wilkins, 1947.
8. Sorsby, A.: Genetics in Ophthalmology. St. Louis, Mosby, 1951.
9. Courtney, R. H., and Hill, E.: Hereditary juvenile glaucoma simplex. J.A.M.A., **97**:1602-1608 (Nov.) 1931.
10. Falls, H.: Instruction Course #227. Am. Acad. of Ophth. & Otol., 1952.
11. Duke-Elder, S.: Textbook of Ophthalmology. St. Louis, Mosby, 1949, v. 4.
12. Falls, H., and Neel, J. V.: Genetics of retinoblastoma. Arch. Ophth., **46**:367-389, 1951.

Ophthalmic Miniature

The lamentable consequences of the Irish epidemic do not seem to be the result of any defect in the Poor-Law, any more than the ravages committed by the Egyptian Ophthalmia among the soldiers of the British Army in 1803 arose from the inadequate resources of the Minister of War, the defective regulations of the Horse-Guards, or the ignorance of and insufficient treatment adopted by the medical officers. In both Tipperary and Athlone, the local guardians were superseded, and vice-guardians appointed; but whichever they are, the guardians of the Irish poor, paid or unpaid, should learn that it is neither justice to those entrusted to their care, nor economy to the rate-payers, not to provide suitable accommodation and other necessaries for the miserable patients, affected with a disease like that on which I have been called on to report.

Ophthalmia in the Tipperary and Athlone Unions,
W. R. Wilde, *London Journal of Medicine,* 1851.

NOTES, CASES, INSTRUMENTS

TONOMETER ADAPTER*

For the Measurement of Scleral Rigidity

R. K. MacDonald, M.D.
Toronto, Canada

The method for determination of scleral rigidity developed by Friedenwald,[1] and now universally adopted, requires two measurements with two different weights by Schiøtz tonometry of the intraocular pressure. Recently, from the study of curves obtained from electronic tonography, Becker and Friedenwald[2] have shown that a temporary elevation in the intraocular pressure frequently occurs the instant a tonometer is placed on the cornea. This elevation in tension appears to coincide with a sudden rise in the diastolic blood pressure. The elevated intraocular pressure falls off again in approximately 15 seconds.

Inconsistencies found in the determination of scleral rigidity may in part be due to such unpredictable changes occurring, as they do, at the time of some of the readings. Other factors, such as the placement of the tonometer foot-plate on a slightly different part of the cornea, or at a slightly different angle to that of the first reading undoubtedly affect the result to some extent. Such inaccuracies sometimes necessitate repeated and painstaking tonometry with two different weights before consistent findings may be recorded.

In an effort to overcome these difficulties, an adapter has been made whereby it is possible to take the second reading immediately after the first without removing the tonometer from the patient's eye. In principle, the 7.5-gm. weight is suspended above the 5.5-gm. weight by two arms, each fixed to one of the tonometer finger supports (fig. 1) in such a way that it does not touch the plunger rod. After the 5.5-gm. weight reading is noted the 7.5-gm. weight is released and the final reading is taken.

The adapter is designed simply as follows: Two pieces of 1.0-mm. aluminum or other light metal are cut in the shape shown in (A) and (B), respectively, of Figure 1. Each is folded in half as indicated and clamped with countersunk nuts and bolts to one of the tonometer finger supports as shown. A layer of thin rubber clamped between the layers of metal ensures joint rigidity.

The aluminum arms are bent and shaped in such a manner that when the foot-plate of the tonometer is resting on the testing block with the 7.5-gm. weight in position, and with the finger supports lowered as far as possible, then the 7.5-gm. weight should lie free between, but not quite touching the ends of the aluminum arms.

In this position the little aluminum finger projecting from arm (B) must come to lie in contact with the upper surface of the 7.5-gm. weight. Slight compression by the operator's fingers causes the ends of the arms to grip the 7.5-gm. weight at its circumference. By virtue of a deliberate twist in the shape of the aluminum arms the weight is engaged in the imaginary straight line between the two finger supports. The tip of each arm should touch approximately three mm. of the circumference of the 7.5-gm. weight.

It is obvious that the junction between the two arms and the 7.5-gm. weight creates a fulcrum about which the weight may turn. To avoid tilting, the weighted or knob side of the 7.5-gm. weight must lie on the side of the fulcrum opposite that of the aluminum finger. It will be noted that the adapter does not in any way interfere with the conventional use of the tonometer.

In the use of the instrument, the 7.5-gm. weight is placed in its conventional position

* From the Department of Ophthalmology, University of Toronto. This work was assisted by a Federal Health Grant.

Fig. 1 (MacDonald). Tonometer adapter for the measurement of scleral rigidity.

over the 5.5-gm. weight. The patient is instructed to fixate on a suitably placed target on the ceiling.

The tonometer is held in the conventional manner between the thumb and first two fingers of one hand. The foot-plate is placed on the testing block or on the patient's cornea. The finger supports are lowered until the aluminum finger touches the upper surface of the 7.5-gm. weight. The fingers are then compressed and the 7.5-gm. weight is grasped by the tips of the aluminum arms. With the foot-plate resting on the cornea, the 7.5-gm. weight is elevated to a point roughly half-way between the hub of the 5.5-gm. weight and the upper end of the plunger rod. After 10 to 15 seconds, when the tension will have become relatively stabilized, the scale reading is noted. Slight, almost imperceptible, relaxation of the index finger releases the 7.5-gm. weight and the second reading is taken.

If any movement of the cornea is suspected at the time of the readings, the process should be repeated. In unco-operative patients it has been found helpful to have an assistant note the readings so that the operator may devote his entire attention to the manipulation of the instrument. In this way, an almost constant position can be maintained between the cornea and the tonometer foot-plate.

Banting Institute (5).

REFERENCES

1. Friedenwald, J. S.: Contribution to the theory and practice of tonometry. Am. J. Ophth., **20**:985, 1937.
2. Becker, B., and Friedenwald, J. S.: Clinical aqueous outflow. Arch. Ophth., **50**:557, 1953.

A LENS TO ENCOURAGE SIMULTANEOUS MACULAR PERCEPTION

K. ELIZABETH PIERCE OLMSTED, M.D.
Buffalo, New York

The phenomenon of strabismus in human vision is a failure of the visual axes to converge upon a fixation point in such a manner that the images fall on corresponding retinal elements to be fused to form a single mental impression. Normally, images stimulating corresponding retinal elements are not seen simultaneously, but successively, at certain intervals, producing physiologic retinal rivalry. Squint usually results in the loss of this retinal rivalry, with a suppression of vision in one eye and causing a decrease of visual acuity in the eye. This suppression is a serious impediment to recovery of normal fusion even after thorough rehabilitation procedures have been instituted. It is to

encourage physiologic rivalry and binocular perception that the new lens herein reported has been devised.

In treating squints, the refractive errors are first corrected. Effort is then directed toward recovery of useful vision in an amblyopic eye by total occlusion. When this has been accomplished, a manifest deviation may need surgical correction before fusion can be established. Visual exercises are then instituted in an endeavor to initiate the experience of fusion. Since formal exercises are necessarily limited, the visual system tends to regress to monocular status, with suppression in the recently reclaimed eye and recession of visual acuity.

The principle of the lens being reported is to provide a method and apparatus by which the visual acuity in the preferred eye is reduced to a degree equal to one or more lines of the Snellen test chart below that of the poorer eye so an incentive will be offered for the constant use of each eye. The acuity must be reduced enough to yield a relatively clearer image in the previously amblyopic eye but at the same time retain an image in the preferred eye sufficiently well-defined so that it cannot be ignored. For example, if the best visual acuity in the reclaimed eye is 20/25, the vision in the fixing eye must be reduced from its 20/15 (or 20/20) to 20/30 or a little less. The lens used for this decrease in acuity must not introduce any secondary deleterious effects, as in the "fogging" technique, for an excessive plus correction may upset the accommodative convergence balance.

The ability of the eyes to resolve detail is related to the spacing of photosensitive nerve cells of the retina. In the average normal eye, clear resolution results when the lines subtend individual widths of one minute of arc and the intervening contrast spaces subtend like angles. The Snellen letters are constructed so that each part subtends an angle of one minute while the whole letter subtends an angle of five minutes for a given distance.

The aim of the present lens is to effect a reduction in the resolving power of the eye. This is accomplished by employing a diffraction grating incorporated in the spectacle lens to form a diffused retinal image. The posterior surface of the prescription lens is treated to produce a suitable arrangement of light-transmitting and light-interrupting areas which allow a pattern of unaffected surface to transmit light in the normal manner but with diffraction.

The lens is so designed that the size of each light-transmitting area produces a diffraction-band effect of the desired spread in the retina to cause a multiple fringe rather than a single image when a line of light or of demarcation between light and dark is focused upon the retina after transmission through the spectacle. The narrower such a light-transmitting area is the greater the fringe or diffraction-band spread.

When the lens is placed before the eye the originally light and dark areas of the unmodified image become invaded by fringe structure so that the residual areas of full contrast fall below the dimensional limits of resolution of the photomental mechanism of the eye. The desired loss of resolution is determined by the construction of the grating to yield variable widths of diffraction bands and, in so doing, decrease the visual acuity by one or two lines of the test chart.

This system does not materially reduce the light transmitting facility of the lens as does the use of clip-on graduated dark glasses whose ability to achieve optimum relative ocular efficiency under a wide range of illumination may be questioned. Nor, like the lacquer-coating sometimes used, does the diffraction grating distort the over-all refractive performance of a lens which may be needed to correct refractive error for normal function of the better eye. The sole effect is to reduce the resolution of detail. Furthermore, no loss of accommodation is induced, nor any imbalance in the accommodative convergence mechanism of the two eyes, as results when the fixing eye is depressed with

the instillation of atropine.*

I usually order the diffraction lens after the reclaimed acuity has held 20/30 or better for several months of total occlusion. Then, by employing the special lens, partial occlusion is introduced. Periodic total occlusion is continued for viewing television and in the evenings but it is gradually eliminated as visual improvement stabilizes. Surgery is done at the indicated time during this period.

The diffraction lens is cosmetically clear so that both the child and the parents are grateful for the change from the total occluder. The children have no complaints about wearing the diffraction lens. They all refer to it as the "checkered glass." There is minimal trouble with side tracking the lens by removing or looking over the tops of the glasses. Double vision is frequently observed when the lens is first put on, thereafter diplopia can be demonstrated in the office. Fixation is sometimes shifted to the second eye but frequently alternation of fixation occurs. This causes gross approximation of retinal rivalry which must be the next step in overcoming suppression. The lens may be worn for an indefinite period of time preferably until the child is over 12 years of age.

Case reports

The use of this lens has proved most satisfactory in amblyopia and squint, due to a high monocular refractive error. It has practically eliminated constant watch of the visual acuity and the necessity for periodically resuming total occlusion. Furthermore it has helped to hold higher visual acuity in the hyperopic eye.

Case 1

T. H., aged six years, had an esotropia of 20$^{\Delta}$. His refractive error was O.D., +1.25D. sph.; O.S., +4.5D. sph.; with corrected acuity of O.D., 20/20; O.S., 20/70. Three months of total occlusion improved the left vision to 20/30, at which time the diffraction lens was used to decrease the right vision to 20/30. The left vision continued to increase and a year later he obtained 20/20 in each eye with fusion at zero on the Troposcope and a limited amplitude to 6$^{\Delta}$ convergence, no divergence. The special lens was removed with a change in glasses after two years and the acuity six months later showed a slight drop. If further loss is noted, the diffraction lens will be replaced.

I have had encouraging results with the accommodative squint when a residual deviation is present after refractive correction and visual acuity improvement.

Case 2

A. W., aged six years, had a refractive correction of +4.0D. sph. in each eye with acuity: O.D., 20/20E; O.S., 20/50E; and a left esotropia of 5$^{\Delta}$. Occlusion for six months increased the acuity to 20/25E, but the left esotropia remained 5$^{\Delta}$. The diffraction lens was then used to cut the right acuity to 20/30.

Four months later the left acuity was 20/30 and the 5$^{\Delta}$ esotropia had reduced to a 3$^{\Delta}$ esophoria. This condition remained stable for one year when the diffraction lens was removed. A similar state was maintained three months later after which contact was lost with this patient for two years.

At the age of 12 years, he returned, still with an esophoria of 3$^{\Delta}$ but a loss of left acuity to 20/40+3. One month's total occlusion brought vision to 20/25 which has been maintained. Resulting vision is 20/20 in the right eye, 20/25 in the left and an esophoria of 3$^{\Delta}$. Today I would not remove the diffraction lens until the patient had reached the age of 12 years.

A similar case is:

Case 3

S. D., aged seven years, began wearing the diffraction lens when her acuity was 20/25E in the right eye; 20/20E, in the left.

* Duke-Elder, W. S.: Textbook of Ophthalmology, St. Louis, Mosby, 1949, v. 4, p. 3917.

with a right esotropia of 5$^{\Delta}$. The lens was removed for a six-month period but replaced due to regression. After two years, the lens was again removed and the result, recorded one year later, was an acuity of 20/20−2L. in each eye with an esophoria of 4$^{\Delta}$ and fusion on the Troposcope from 0-11$^{\Delta}$.

I have found this lens very helpful as an adjunct in overcoming an abnormal retinal correspondence. The following case is encouraging:

CASE 4

C. N., aged five years, had a history of left esotropia from birth. His refraction was: O.D., +2.75D. sph. ⌒ +1.0D. cyl. ax. 90°; O.S., +3.25D. sph ⌒ +1.0D. cyl. ax. 90°; corrected acuity was O.D., 20/20; O.S., 20/200; and his deviation measured 20$^{\Delta}$ for distance and 30$^{\Delta}$ for near.

Total occlusion for five months improved the left vision to 20/25 with a corrected deviation of 14$^{\Delta}$ esotropia for near. Troposcope examination revealed an abnormal retinal correspondence of 6$^{\Delta}$.

Orthoptic training was given for eight months with little evidence of overcoming the abnormal projection. At that time the diffraction lens was prescribed and a rest from orthoptics given. Six months later his troposcopic examination showed a confusion of his retinal areas with dominance of the foveal area. Eight orthoptic treatments were given before the patient was absent. Eighteen months later he returned, still wearing the diffraction lens, with only a 4$^{\Delta}$ esophoria.

Now, at the age of 10 years, he has a visual acuity of 20/20, O.D.; 20/25, O.S.; with an esophoria of 2$^{\Delta}$ for near and is fusing at zero on the Troposcope with an amplitude from X −4$^{\Delta}$ to E −6$^{\Delta}$. He is still wearing the special lens.

An interesting report is that of recovery from a postoperative exotropia.

CASE 5

J. K., aged nine years, had a past history of a left esotropia which was operated at age five years. His refractive error was: O.D., +0.5D. sph. ⌒ +0.75D. cyl. ax. 100°; O.S., +3.5D. cyl. ax. 85°; with acuity of 20/25 and 20/50, respectively. There was a left exotropia variable from 12$^{\Delta}$ to 30$^{\Delta}$. Total occlusion for five months brought the left acuity to 20/30. Orthoptic training helped to stabilize his fusion and he had episodes of maintaining fusion although he still presented an intermittent external deviation of 12$^{\Delta}$.

The diffraction lens was then employed to reduce his right acuity of 20/30. The intervals of deviation became less frequent and gradually orthophoria was sustained. The left acuity increased to 20/25. The diffraction lens was removed one year later. At the present age of 14 years, he has 20/20, O.D.; 20/25, O.S.; with an exophoria of 8$^{\Delta}$. His former reading difficulties have been completely overcome and he is in the advanced reading group in his class.

SUMMARY AND CONCLUSIONS

Suppression in a squinting eye forms a serious impediment to the recovery of normal fusion even after rehabilitation procedures have been thoroughly instituted. This new lens has been devised for the encouragement of binocular perception.

The principle is to provide a method and apparatus which reduces the visual acuity in the preferred eye by one or more lines of the Snellen chart below that of the poorer eye so an incentive will be offered for the constant use of each eye. The acuity must be reduced enough to yield a relatively clearer image in the previously amblyopic eye but at the same time retain in the preferred eye an image so well-defined that it cannot be ignored.

The aim of the lens is to effect a reduction in the resolving power of the eye. This is accomplished by employing a diffraction grating incorporated in the spectacle lens to form a diffused retinal image.

The diffraction lens has been readily ac-

cepted by both patients and parents. It accomplishes its purpose in encouraging continuous concurrent use of both eyes. Its use in 50 cases (admittedly too few for broad statistical conclusions) have given such encouraging results that I am convinced further use will demonstrate this lens to be a substantial aid in the treatment of squint.

568 Lafayette Avenue (22).

A LID SPECULUM*

SAMUEL D. MCPHERSON, JR., LT. COMDR. (MC) USNR
Bethesda, Maryland

We have recently used a lid speculum which has been more satisfactory in our hands than those which are presently available. This speculum is shown in Figure 1.

Fig. 1 (McPherson). Lid speculum showing solid blades with posts and locking screws.

It combines what we feel are the best features of several speculums already available.

The speculum is made of nonmagnetic stainless steel. The blades are solid in order to cover the lashes at the 12- and 6-o'clock positions and are hinged to pull the lids up and away from the globe. There are posts on both the upper and lower blades for securing bridle sutures for ocular fixation. The speculum is automatically spread by a spring on its under surface. Turning the outer screw permits opening of the speculum and turning the inner screw exerts positive pressure in separating the lids and enables one to lock the speculum in the desired position. There are no vertically projecting screws or exposed springs which might entangle sutures.

The speculum has been used by our staff in a variety of eye operations with satisfaction.

EENT Service.

A NEW SURGICAL GALVANIC UNIT*

S. I. ASKOVITZ, M.D.
Philadelphia, Pennsylvania

The application of galvanic electricity for the performance of a variety of surgical procedures[1] has been known for many years. This type of electrical current has been available for electrolysis and iontophoresis by means of a number of instruments[2] on the market. Recently, the use of the galvanic current in major ocular surgery has received further attention, and the operation of cycloelectrolysis has become a valuable addition to the therapy of glaucoma.[3,4] In most cases, it is necessary to provide about five milliamperes of direct current, at 22.5 volts or more.

* From the Department of Ophthalmology, U. S. Naval Hospital, National Naval Medical Center. This instrument is manufactured by the E. B. Meyrowitz Company, New York, New York.

The opinions expressed herein are those of the author and do not necessarily express the views of the U. S. Naval Corps.

* From the Albert Einstein Medical Center, Northern Division, Ophthalmology Research Laboratory (Dr. I. H. Leopold, Director). This work was made possible by a grant from the Weinstock Fund. The surgical galvanic unit is being manufactured by the Locust Optical Company, Instrument Division, Philadelphia, Pennsylvania.

Fig. 1 (Askovitz). The new surgical galvanic unit.

Many of the smaller power units[3] do not provide a sufficient output. With this in mind, a new unit was constructed at this laboratory, using an adequate dry-cell battery capable of supplying up to nine milliamperes of galvanic current (fig. 1). This self-contained power source is independent of any special external voltage, and it does not need to be grounded. Furthermore, it completely eliminates the possible 110-volt shock hazard inherent in plug-in line-operated units.

A selector switch permits use of either a low range (for electrolysis of cilia or removal of minor growths), or a higher range for more extensive procedures, and there is a rheostat control for fine adjustment. The neutral electrode originally developed for use with electrolysis and iontophoresis[2,5] has proved to be quite satisfactory with this new galvanic unit also. The specially coated aluminum bar is grasped by the patient's bare hands. "Electrode jelly" has been found to be unnecessary. The active electrode, obtainable with an insulated clip or with the usual pencil-shaped end to receive suitable needle tips, is attached to the negative outlet. A meter on the front panel indicates accurately the current in use, to a fraction of a milliampere.

The type of battery employed should ordinarily last about two years or even longer. A test button allows checking the state of the battery at any time, without the need for tools or test equipment. The test circuit diverts all the current from the panel outlets, so that the test button may also be used as an instantaneous cut-out switch, in case the initial current is excessive or the local anesthesia inadequate. The entire assembly is contained in a Bakelite enclosure, 6¾ by 5¼ by 2⅜ inches in size.

York and Tabor Roads (41).

REFERENCES

1. Sultzberger, M. B., and Heinlein, J. A.: Section on "Direct current," in Medical Physics, Chicago, Year Book Publishers, 1950, v. 2, pp. 990-991.
2. Askovitz, S. I.: An improved electrolysis-iontophoresis unit. Am. J. Ophth., **38**:719-720 (Nov.) 1954.
3. Berens, C., Sheppard, L. B., and Duel, A. B., Jr.: The surgery of glaucoma: Cycloelectrolysis versus cyclodiathermy. Acta XVI Concilium Ophthalmologicum (Britannia), 1950, pp. 956-970.
4. ———: Cycloelectrolysis for glaucoma: Am. J. Ophth., **34**:53-70 (Jan.) 1951.
5. Askovitz, S. I.: Several new and improved electronic devices. J. Albert Einstein M. Center, **2**:173-178 (Aug.) 1954.

INSTRUMENT DESIGNED TO TEST DIPLOPIA FIELDS*

WALTER H. FINK, M.D.
Minneapolis, Minnesota

The instrument (fig. 1) is designed to simplify the study of diplopia fields, and is particularly valuable in the analysis of torsional defects.

It consists of a small flashlight on which is mounted an elongated head at right angles to the flashlight. The head has a slit which produces a narrow line of light when the light is on.

The test is carried out in a dimly lighted room with the patient holding a red glass in

* Made by the Benson Optical Company, Minneapolis, Minnesota.

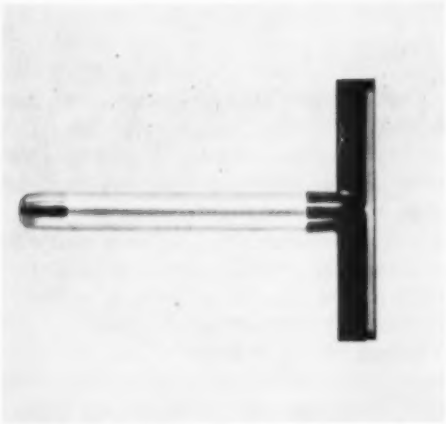


Fig. 1 (Fink). Instrument to test diplopia fields.

front of one eye. The instrument is moved into the cardinal fields of vision and the patient indicates the relationship of the two lines if diplopia is present.

Because the test does not necessitate the use of a screen, it can be performed in the examining chair. This important test can thus be made part of the routine investigation and is especially valuable in the analysis of the vertical defects. Because of its simplicity, it can be used profitably even in the young patient.

1921 Medical Arts Building (2).

INSENSITIVITY TO COMMONLY USED ANTIBIOTICS*

Of a strain of Micrococcus pyogenes

Ted Suie, Ph.D.
Columbus, Ohio

Although the development of bacterial resistance to various antibiotics is a well-known phenomenon, a complete qualitative resistance of a strain to all the commonly used antibiotics must indeed be rare. Therefore, it seemed worthwhile to report on a strain of Micrococcus pyogenes var. aureus (coagulase positive) which was isolated from the lower cul-de-sac of a nine-day-old Negro infant suffering from an acute blepharoconjunctivitis (O.U.).

The organisms which were grown on blood brain-heart infusion agar were tested against the following antibiotics using bactosensitivity discs.†

Antibiotics	Concentrations
Aureomycin	60, 30, 10 µg.
Bacitracin	20, 10, 2 units
Choromycetin	60, 30, 10 µg.
Dihydrostreptomycin	100, 10, 1 µg.
Penicillin	10, 1, 0.5 units
Polymyxin B	30, 10, 5 µg.
Terramycin	60, 30, 10 µg.
Neomycin	60, 30, 10 µg.
Tetracycline	60, 30, 10 µg.
Erythromycin	10, 1, µg.

In no instance did this organism exhibit sensitivity to any of the antibiotics in the concentrations used in this study. The Furacin‡ (10 mg.) disc produced a 24-mm. zone of inhibition which may be considered significant.

This report would indicate that organisms resistant to all the usual antibiotics may occur in external ocular infections. This could obviously pose important problems from the clinical as well as the epidemiologic point of view.

Department of Ophthalmology.

* From the Department of Ophthalmology, The Ohio State University College of Medicine.

† Difco Laboratories, Detroit 1, Michigan.

‡ Eaton Laboratories, Inc., Norwich, New York.

I wish to thank Dr. Alfred L. Joseph for submitting the material for bacteriologic examination.

SOCIETY PROCEEDINGS

Edited by DONALD J. LYLE, M.D.

NEW ENGLAND OPHTHALMOLOGICAL SOCIETY

November 17, 1954

The 420th meeting of the New England Ophthalmological Society was held at the Massachusetts Eye and Ear Infirmary, Boston. At the afternoon session several interesting clinical cases were presented and discussed; there was a pathologic conference on malignant melanomas of the eye, directed by Dr. Taylor R. Smith; and a paper describing a simple device for tonometer sterilization by Dr. Knud K. Dreisler. The device holds the tonometer over an alcohol lamp, and sterilization is by open flame.

In the evening session, following a brief business meeting, two scientific papers were presented:

UNILATERAL EXOPHTHALMOS

DR. HUGH DONAHUE, Boston, presented the case of a 25-year-old white woman who had first been seen by him at the age of three years for treatment of a unilateral exophthalmos which was proved pathologically to be caused by a glioma of the optic nerve. Following enucleation the recovery was uneventful but the pathologic section at that time showed invasion of the intervaginal space of the nerve. The patient had been seen in consultation by Dr. Harvey Cushing who advised no further surgery at that time.

She was not seen again until 22 years later when she was seen by Dr. Donahue, and he observed a marked recurrence of the tumor which he described as being "the size of a tennis ball," and which had been covered with an ordinary black ocular patch for several years, so that the patient had lived a useful and active life doing secretarial work without her friends being aware of her difficulty.

The literature on this problem was reviewed, and it was pointed out that local orbital recurrence was very unusual; that the usual postoperative course on this type of lesion is intracranial extension, and that the tumor is notoriously lacking in a tendency to metastasize. Plastic surgery was suggested to the patient who, on the advice of her family, refused further treatment.

Discussion of this paper was directed mainly toward the very unusual feature of local orbital recurrence in this type of tumor.

OBSERVATIONS ON ANESTHESIA

DR. WALTER S. ATKINSON, Watertown, New York, presented the second scientific paper of the evening. His discussion was limited to local anesthesia for intraocular operations.

Dr. Atkinson pointed out the importance of proper preparation of the patient with preoperative sedation and stated that in his own practice, he often gives pre-anesthetic test doses in order to be better able to gauge the patient's response to various sedatives, and he added that he has been using phenergan hydrochloride as an agent to prevent nausea and vomiting and had been very much satisfied with its effects. He emphasized that different patients require different dosages to obtain the same results, and that the choice of drug and dosage is important. The factors which govern this usually are the patient's age, the type of operation and the type of anesthetic to be used, as well as the patient's metabolic activity and state of nervous agitation. He stated his usual choice of preoperative sedation was short-acting barbiturates such as Nembutal or Seconal, and that he uses chloral hydrate if these are contraindicated.

His usual practice is to start the preoperative medication approximately one and one-half hours before operation, giving pentobarbital (Nembutal), 0.2 gm.; Bufferin, 0.3

gm.; and Demerol, 50 to 100 mg., depending on patient's age, weight, and general physical condition. If the patient is not adequately sedated at one-half hour before operation, an additional dose of 0.05 to 0.1 gm. of Nembutal would be given. He stated that the functions of the preoperative medication are to produce psychic depression, to reduce reflex irritability, to slow metabolism, and to counteract any toxic effects of the anesthetic agent.

Dr. Atkinson's choice for local anesthesia is topical administration of tetracaine (Pontocaine) and injection of lidocaine (Xylocaine), two percent, containing 1:50,000 epinephrine and six TRU hyaluronidase, and stated that his choice for lidocaine was because he found that it lasts longer and gives a more profound anesthetic effect than procaine.

He strongly advocated the use of a different approach for blocking the facial nerve to produce akinesia of the lids. He suggested that the injection be started at the inferior border of the zygomatic bone, that it be carried across the zygomatic arch toward the top of the ear, though not as far as the top of the ear, and that the point of the needle be kept close to the bone. The index finger of the free hand should be placed over the facial vessels to prevent them from being pricked by the needle and to help guide the direction of the injection. He advised the use of a 3.5-cm. 23-gauge needle with a rounded point to cut down hemorrhage resulting from damaging a blood vessel. After the injection is completed, pressure should be applied over the area to give better diffusion and provide a more complete block.

He stated that this technique has marked advantages over the Van Lint method in that it does not produce any lid swelling and that its chief advantage over the O'Brien type of block is that there is no danger of discomfort caused by injury to the condyloid process or by pricking the periosteum in that region.

Also he added that the landmarks are very readily found even in obese patients. He stated that he had never missed getting complete akinesia using this type of nerve block. However, regardless of what type of block a surgeon decides to use, he should be sure of complete akinesia before starting surgery.

In addition to the akinesia for the orbicularis, Dr. Atkinson advised the use of retrobulbar anesthesia to give ocular akinesia, anesthesia, and hypotony. He acknowledged the chief danger of a retrobulbar injection was that of retrobulbar hemorrhage, but stated that he felt this was due primarily to the use of long sharp-pointed needles. This danger can be minimized by using a round-point 3.5-cm. needle instead of a sharp needle 5.0 cm. long. In order to introduce the rounded point needle, it requires a boring action at the surface of the skin and again when the orbital septum is encountered. He advised making the retrobulbar injection beginning close to the inferior temporal margin of the orbit with the patient looking up and away from the site of injection. This is done in order to get the inferior oblique forward and out of the way. The needle should then be introduced straight back toward the floor of the orbit until the point is beyond the globe, then it should be redirected into the muscle cone.

When hyaluronidase is used, more solution is injected, and he advised injecting solution until there is a noticeable proptosis —usually requiring about two to three cc. He added that, before injecting, he always withdraws the plunger of a syringe in order to check for entering a blood vessel but that he has never aspirated blood.

After the injection is completed he applies pressure over the globe for five minutes and the globe is rotated in the orbit manually. Usually he injects a small amount of solution into the superior rectus and into any other muscle which shows activity. In addition, a small amount of anesthetic agent is injected at the supraorbital notch in order to produce anesthesia of the lid. He added that he routinely checks the tension of the eye

with a tonometer and does not start his surgery until the pressure is well down (that is, below 15 mm. Hg). His talk was illustrated with several well-selected slides of the procedures he described.

Discussion. Dr. E. B. Dunphy mentioned that at the Massachusetts Eye and Ear Infirmary several months ago, the anesthesia service had advised the discontinuance of four-percent procaine which had been routine for several years because of the theoretical possibility of toxicity to the motor nerves. However, because of incomplete anesthesia resulting from the weaker solution, the surgeons on the staff had requested the operating room return to the use of the four percent which has been done, and no untoward effects have been observed.

A question was asked whether Dr. Atkinson had observed any toxic effects in the use of lidocaine, and he stated he had seen none. Further discussion emphasized the need for prevention of vomiting and for as nearly complete relaxation of the patient as possible before beginning surgery. Dr. Atkinson agreed with others who brought up the subject, that Demerol does indeed seem to produce vomiting in some patients, but that vomiting had been much less when he included the use of phenergan hydrochloride in his preoperative medication.

David H. Scott,
Recorder.

COLLEGE OF PHYSICIANS OF PHILADELPHIA

Section on Ophthalmology

April 15, 1954

Dr. Perce DeLong, *chairman pro tem.*

Congenital corneal and facial anesthesia

Dr. William C. Frayer (by invitation): Corneal and facial anesthesia as a result of congenital defects in the fifth cranial nerve have been infrequently reported. Because definite proof of nuclear or nerve aplasia has been lacking in these reports, some authors have denied the existence of such an entity. A child with bilateral anesthesia of the corneas and of the skin of the face in the distribution of the fifth nerve, noted shortly after birth, has been observed for the past four and a half years at the Children's Hospital of Philadelphia.

The patient was first admitted to Children's Hospital on September 7, 1949, at the age of five months. He had been born with imperforate anus and a rectovesical fistula. Operative repair of these anomalies on the day of birth had resulted in a rectal stricture and the child was referred to the Children's Hospital for evaluation. Routine ocular examination at this time was negative, although corneal sensitivity was not tested.

After repeated rectal dilatations, the patient was discharged from the hospital, but was readmitted on November 3, 1949, because of bilateral corneal ulcers and malnutrition. Examination confirmed the presence of ulceration of both corneas in the exposed areas, with very little ciliary or conjunctival injection. Neurologic examination revealed loss of sensation to pinprick on the face and forehead bilaterally in the distribution of the fifth cranial nerve. Skull and chest X-ray films were negative. Laboratory examination of blood and urine, serologic tests for syphilis and tuberculin test were all negative.

The corneal ulcers could not be controlled by local and systemic antibiotics or by careful shielding of the eyes. Prompt corneal healing occurred, however, after bilateral median tarsorrhaphies were performed. The lids were reopened after the child had been symptom-free for one year but lateral tarsorrhaphies were performed in August, 1952, because of subsequent breakdown of the corneal epithelium.

During the period of observation it became increasingly evident that the child's mental and physical development were markedly retarded. At the age of five years,

he was still unable to sit or stand alone. He showed marked general muscular atrophy, hyper-reflexia and a limited awareness of his environment. A large ulceration of the skin of the forehead developed as a result of rubbing the head against the floor and other rough surfaces.

Feeding was a constant problem. On March 3, 1954, the patient refused food altogether, and was admitted to Children's Hospital on March 11, 1954, with marasmus, dehydration, septicemia, and multiple skin abscesses. Supportive measures failed and he died on March 14th. It is unfortunate that permission for post-mortem examination could not be obtained.

Although true congenital aplasia of the third, sixth, and seventh cranial nerve nuclei is said to occur occasionally, absence of the fifth nerve nucleus has never been proven. Ford has stated that, as far as he can determine, sensory defects of the fifth nerve do not occur congenitally. Patients with corneal anesthesia, thought to be on a congenital basis, have been reported, however, by Lawford and Kayser. Franceschetti reported a four-generation pedigree of a family with diminished corneal sensation associated with herpetic lesions of the cornea. Acquired causes of nerve damage such as wounds, fractures, meningeal infections (notably syphilis and tuberculosis), tumors, hemorrhage, and aneurysm must always be ruled out, but Kinnier-Wilson states that the presence of other congenital anomalies or an hereditary occurrence of hypesthesia must be considered as evidence in favor of nuclear aplasia.

The patient reported here is presented as a possible example of true congenital corneal and facial anesthesia. The co-existence of other congenital anomalies and the failure to uncover evidence of acquired causes of nerve damage are factors which tend to support this contention.

Discussion. Dr. George D. Gammon: Dr. Frayer has given a very succinct presentation of the case report of this child, and it illustrates some of the difficulties of coming to a conclusion concerning the origin of his defect. I saw this child only once at the age of five months, and unfortunately did not see him in his later years. However, he was seen in the Neurologic Clinic at the Children's Hospital, at the age of five years at which time the problem was not focused on the question of whether he had a congenital absence of fifth-nerve function. The child had been at a mental institution and had gone down hill while at this institution so the problem of disposition was the one that was of most concern at that moment.

It was apparent, however, to the man who saw him at the clinic that this child was very backward in function and sensation. He was unable to stand without support but, when held up, he could make stepping movements. It is said that he was scarcely aware of his environment; would respond with a smile occasionally to a sound. He seemed not to respond very much to tactile or pinprick sensation.

As I say, this was not a detailed examination, unfortunately, with the point of view of whether this represented a congenital anomaly of the fifth-nerve sensory region. I think from the point of view of classifying this case, we will say that this child, who had several congenital defects, aneurysms among them, and I believe a fistula, had failed to develop. He was a spastic child with bilateral Babinsky sign, and completely devoid of speech or obvious sensation at the age of five years. I am stating this on the basis of notes rather than personal observation. He apparently had corneal anesthesia at five months of age accompanied by the ulceration described. Perhaps it might be helpful to consider the possibilities of such a patient in the abstract and see if any of them can be applied to him.

As Dr. Frayer has said most congenital absence of function of cranial nerves have been in the motor third, sixth, seventh, and so forth. The exceptions are the special senses of vision and hearing and taste where

there have been case reports of congenital absence. Occasionally reports implicate either an acquired decompression or compression of the nerves by congenital anomalies. I recall one chap who had a peculiar distribution of bone at the base of his skull with fifth and seventh nerve involvement; the anomaly proved to be transitory, curiously enough, although there was this large hump on the bones in the middle fossa.

In recognition of pain, one must have a periphery apparatus; impulses concerned with pain are conducted inward to reach the muscle and ultimately the cortex. Of course an interruption of any of these pathways, which travel within the peripheral or central nervous system, can result in the failure to recognize pain in that territory. It is also apparent, however, from recent work on frontal lobotomy cases, that the reaction to pain differs, or the appreciation of pain may differ. With lesions in the frontal lobotomies, although the patient is able to perceive pain, he does not react to his pain, and does not complain of it. Unawareness or failure to react to pain may occur with lesions in the supramarginal gyrus. The patient may be unaware of the opposite side of his body or may be unaware of paralysis on the opposite side of his body. That has been reported in a few instances in which pain, also failure to recognize pain, was a part of the picture and it proved to be a transitory affair.

Finally, there is the situation in which, apparently, there is a congenital inability to feel or react to pain. This is universal in the sense that the whole body is involved. A few cases of that sort have been described, some recognized in childhood. The patients have had pain, fractures, perforated visci, and so forth. As far as I am aware, there are no pathologic data on those patients as to where the lesions may be, if any, which are responsible for this failure to recognize pain as a painful sensation. Into which of these various possible categories this patient would fit I don't know. I have made a rather superficial search in the neurologic literature and I have not come up with any description of congenital absence of the fifth nerve function alone.

Retinopathy in unselected diabetics

Dr. T. H. Cowan, Dr. P. L. Carmichael (by invitation), and Dr. F. Campagna (by invitation): The fundi of 500 unselected diabetics were examined to determine the incidence of diabetic retinopathy in the diabetic population and the relationship of the degree of retinopathy to control, severity and duration of the disease.

The basic lesions of diabetic retinopathy were considered to be small round hemorrhages and small, sharply defined, hard yellow-white exudates. For the purpose of study, the patients with retinopathy were grouped into four categories ranging from involvement with few hemorrhages and exudates to the typical proliferative retinopathy. Any additional fundus lesions which were not considered to be a part of the true diabetic retinopathy were listed under separate headings.

Venous aneurysmal dilatations were subjected to special study, since at the present time they are considered to be one of the earliest signs of diabetic retinopathy. They were present in only 37 (7.4 percent) of the 500 cases in this series. Of these 37 cases only nine were found in otherwise normal fundi.

Arteriosclerosis was found to be present in only 100 cases (20 percent).

Some degree of diabetic retinopathy was present in 216 (43.2 percent) of the cases. Of the total diabetics only 34 cases (6.8 percent) fell into categories III and IV (severe and very severe retinopathy).

The standard criteria of diabetic control were used to place the patients into three groups of good, fair, and poor control. It was found that there was little correlation between the control of the diabetic patient and the incidence and severity of the retinopathy.

Similarly, the severity of the clinical diabetes seemed to have very little influence on the degree of retinal involvement. Severity, in contradistinction to control, includes the incidence and degree of diabetic complications such as gangrene, peripheral vascular disease, and arteriosclerotic heart disease.

There is a definite increase in the incidence of diabetic retinopathy of all types with the passage of time. Of 228 cases in which the duration of diabetes was five years or less, retinopathy was present in 64 patients (28 percent). In 107 cases in which diabetes was present for five to 10 years, retinopathy was present in 48 cases (45 percent). In those cases in which diabetes had been present for 10 years or longer the incidence of retinopathy rose to 61.5 percent and remained at approximately this level regardless of the duration of the disease. (This study included patients who had diabetes for more than 30 years.)

Discussion. DR. STANLEY SPOONT: There is no doubt that Dr. Cowan has raised problems that are important to the internist. Degenerative vascular disease is a tremendous problem, especially in those patients who are kept alive for a long enough time to develop such complications.

It is extremely difficult to define the control of the diabetic patient. The internist sees these patients perhaps once a month, and is necessarily unaware of the patient's status during the intervening period. The essence of the problem is the control of diabetes for years and years, and it is often impossible to perform the great number of tests that would be necessary to insure perfect diabetic control. However, a start must be made at some point, and I think Dr. Cowan has illustrated the standards that are usually used.

It is also hard to define the severity of diabetes. Although there are no definite criteria, most people take an amount of insulin, depending on the state of nutrition and the occurrence of acidosis.

It is interesting that we studied a similar series a few years ago at the University Hospital in co-operation with Dr. Dyer and Dr. Day and found the incidence of diabetic retinopathy about 42 percent. Dr. Cowan mentioned a 43-percent incidence and Dr. Brill's group is in the 40-percent range. Thus I believe the incidence is close to this figure.

As to whether the control of diabetes is important or not, Dr. Dyer and I believe that the control of the diabetes is important. Others, including Trolstoi in New York, take another point of view; which view is correct will be decided in the future.

The factor which we consider the most important at the present time is the duration of the diabetes. I agree with Dr. Cowan that there are diabetics so poorly controlled that they present blood sugars of 400 or 500 mg. percent week after week, and yet examination of the eyes fails to reveal any retinopathy. Surely there must be conditions other than the control of the diabetes of importance. Some of these patients, youngsters generally, are on the verge of acidosis all the time, may be poorly nourished for years, and do not develop changes in the eyes.

Recently, there have been some interesting suggestions regarding diabetic retinopathy. Perhaps the mucopolysaccharides of the blood may be implicated, or the blood protein may be abnormal. Elevated blood fat levels in conjunction with kidney lesions often, if not invariably, associated with the retinal lesion have an effect which at present is not too clear. Reports have appeared on the production of microaneurysms in patients' eyes following administration of ACTH. Retinopathy in diabetics is sometimes made worse by pregnancy. All these suggest a hormonal effect in some way. Some cases suggest that if, as Dr. Cowan says, a new picture of some type of endocrine imbalance is occurring in some of these cases, the adrenal gland may be implicated although any certainty would be premature.

CLINICAL EVIDENCE OF THIRD-NERVE NUCLEAR ARRANGEMENT

DR. FREDERICK HARBERT (Capt. [M. C.] U.S.N. by invitation) reviewed the literature on third-nerve nuclear arrangement and reported four cases of unilateral upward-gaze palsy with and without ptosis. The association of ipsilateral inferior rectus involvement of lesser degree was reported, apparently for the first time. This may account for the large binocular field in many such cases without requiring changes in the position of the head. The classical bilateral functional arrangement postulated by Brower and Bernheimer was not supported by these clinical cases. The clinical evidence is consistent with the more recent experimental evidence of ipsilateral innervation by Szentagothai, Davis, Bender, and Weinstein.

Discussion. DR. FRANCIS H. ADLER: Dr. Harbert has presented four cases in which a definite paralysis of a superior rectus and an inferior oblique muscle was associated with a paralysis of an inferior rectus muscle in the same eye. Since the other muscles in this eye supplied by the third nerve escaped, that is, the medial rectus and the internal ocular muscles, he places the lesion in the third-nerve nucleus on that side.

A nuclear lesion which would catch these three muscles can be better explained on the basis of the arrangement of the nuclei which has recently been found in animals by the use of the Horsley-Clark stereotactic apparatus than on the basis of the older arrangement proposed by Bernheimer and Brower.

As Dr. Harbert states, cases of unilateral superior rectus and inferior oblique paralysis alone are not too rare. An associated paralysis of the inferior rectus on the same side is a very rare occurrence.

The following cases are illustrative of the former condition (slides of two patients). The confusing part of the picture in these cases is that there is usually present an inhibitional palsy of the yoke muscle antagonists, suggesting a true paralysis of the inferior rectus and the superior oblique muscle of the opposite eye. It is difficult, and sometimes impossible, to determine which group of muscles is really paralytic and which muscles are merely obeying Hering's law and underacting on physiologic principles.

Most of these cases show either true ptosis or pseudoptosis, as reported by Kirby, but lid retraction may be present, as the following case illustrates (slides of one patient).

In my experience, it is extremely rare to find an inferior rectus palsy on the same side. Of the four cases reported this evening, Case 4 seems to meet best all of the criteria necessary to establish this diagnosis. The pictures show a strabismus in the characteristic motor fields of all three muscles, and the diplopia fields are in accord with these.

The pictures of Case 1 show a definite left superior rectus and inferior oblique palsy. Further, on gaze down and to the right, a right hypertropia is evident. The measurements given show no measurable separation down and to the left. I find it hard to accept a paralysis of the left inferior rectus on the evidence given, but knowing Dr. Harbert's meticulous care in making such examinations, I am willing to accept it on faith.

The right hypertropia on gaze down and right can be explained on the basis of inhibitional palsy of the right inferior rectus issuing from a left inferior oblique palsy but, if one wished to be contrary about it, it could also be said to be due to a true palsy of the right inferior rectus. This would be in keeping with the Bernheimer arrangement of the third-nerve nuclei, in which the inferior rectus innervation is supposed to be crossed to the opposite side of the nucleus.

In Case 2, the pictures fit a paralysis of all three muscles but the measurements were not entirely satisfactory.

In Case 3, the pictures show a paralysis of the left superior rectus and inferior oblique but the eyes look in alignment, or

even suggest a right hypertropia on gaze down and to the left. Measurements showed 2.0D. right hypertropia down and to the right and 2.0D. left hypertropia down and to the left.

Until more of these cases can be collected and studied, as Dr. Harbert has done, it would seem wise to me to admit that our knowledge of the arrangement of the nuclei in the third-nerve mass in man is still entirely conjectural. The evidence he has presented is valuable and points in the direction he has suggested.

DR. EISENBERG: Dr. Harbert placed the lesion in the nuclei. I would just like to speculate on the possibility of a retro-orbital lesion causing the paresis of elevation. Would you mind commenting on that please?

CAPT. HARBERT: In answer to Dr. Eisenberg's question about a retro-orbital lesion, I would presume he was thinking of something between the sphenoidal fissue and the brain stem?

DR. EISENBERG: No, in the orbit itself, space-taking lesions.

CAPT. HARBERT: In the first place, the third nerve divides at the superior orbital fissure or perhaps just before it enters the orbit. The superior branch carries levator and superior rectus fibers while the inferior oblique fibers go with the inferior branch.

In the cases reported we have a mechanical involvement of superior and inferior muscles which are innervated by different branches of the nerve. On that basis, I think we can rule out a single lesion that could account for this. We also have the medial rectus completely spared in all these cases, which again rules out an orbital lesion. It would take a peculiar lesion to spare the medial rectus and give maximal involvement of the other two muscles that are innervated by the inferior division.

I certainly think Dr. Adler's criticism is very proper. Perhaps I was a little too enthusiastic in reading inferior rectus involvement in some of the cases. However, I will try to find a better data to substantiate my theory and, if I can, I will present the findings to you.

William E. Krewson, 3rd,
Clerk.

MEMPHIS EYE EAR, NOSE, AND THROAT SOCIETY

OPTIC NEURITIS TREATED WITH CORTICOTROPIN

DR. PHILIP MERIWETHER LEWIS presented a 37-year-old Negress with an acute fulminating optic neuritis who was under treatment at the Memphis Eye and Ear Hospital. She first noticed marked blurring of vision of her left eye five weeks previously. There had been practically no headache and no pain. Her health had always been excellent. She had seven children, all living and well, the youngest being four years old.

Examination showed both eyes normal externally, the media clear, and the fundus of the right eye normal. The disc of the left eye was greatly swollen, the peak of the elevation being eight diopters and the lowest portion four diopters above the normal level. The retina surrounding the disc was greatly swollen, the veins enormously engorged and there were many flame-shaped hemorrhages. Vision was 20/20 in the right eye and 20/200 eccentrically in the left eye. The visual fields and blindspot of the right eye were normal. The peripheral field of the left eye for large test objects was normal and there was a fairly large central scotoma. There was no limitation of motion, no proptosis, and no tenderness to pressure. Her physical examination was entirely normal except for two diseased teeth which she had removed during the early stage of her trouble. X-ray studies of the remaining teeth, gums, sinuses, and chest were negative.

The removal of the diseased teeth, injec-

tions of typhoid-H antigen intravenously, and large doses of nicotinic acid failed to cause any improvement in the appearance of the fundus or in the vision. Corticotropin was therefore started by a slow intravenous drop over an eight-hour period. The medium used was five-percent glucose solution in distilled water; 1,000 cc. containing 40 mg. of corticotropin were administered over an eight-hour period. The same dose was repeated the next day and thereafter the amount was gradually reduced. It was planned to "taper" off with cortisone by mouth after discontinuing the corticotropin.

Considerable reduction of swelling and some visual improvement were noticed, but it was too early to claim great benefit from the drug. A subsequent report will be made after the process has completed its course.

Pituitary tumor

Dr. C. C. Shipp reported the case of a 51-year-old Negress who came to the clinic on April 20, 1953, with a complaint of failing vision for over two years. Her present glasses were six months' old, purchased from an optometrist at a jewelry store, and she said she could not see out of them. There was no history of ocular pain or trauma and no previous eye complaints.

Examination. The eyes were white and external examination was negative. Visual acuity was: O.D., counting fingers; O.S., light perception; with a +2.0D. sph., add +2.0D. sph., O.U.; J18,(?) O.D. Cornea and media were clear. Pupils were small but equal, reacted to light and accommodation, consensual reactions were positive, O.U. Tension was: 20 mm. Hg (Schiøtz), O.U.

Fundus examination. There was optic atrophy, O.U., especially the temporal sides of the discs. Grade I arteriolosclerosis of the vessels was present; no cupping was seen.

Primary optic atrophy was considered though no history of any antiluetic therapy was found. Blood Kahn was obtained and the patient was told to return for re-examination of the fundus and possibly field studies.

Ten days later, on April 30, 1953, when she returned, it was noted that she could get around very well for being able to see fingers only. A consultant recommended field studies and a spinal fluid Kahn, although blood Kahn was negative. A re-check of the fundi showed advanced optic atrophy, O.S.; moderate, O.D., and a few cortical lens changes below. Peripheral field studies showed irregular constriction for the right eye and only the inferior nasal quadrant and a small segment of the superior nasal field remaining in the left eye.

Lumbar puncture was done on May 1, 1953, with an initial pressure of 120 mm. H_2O. Quaeckenstedt rose to 260 mm. with a final pressure falling quickly to 65 mm. H_2O; the fluid was crystal clear. Laboratory studies showed total protein 40 mg. percent; cell count: 2.5 c.mm. 100 percent lymphocytes. Spinal fluid Kahn was negative. Anteroposterior and lateral skull X-ray films showed destruction of the pituitary fossa with preservation of the anterior clinoid process. The sella dimension measured over 3.0 cm. in the anteroposterior diameter.

Neurosurgical consultation was obtained May 4, 1953, and a tentative diagnosis of chromophobe adenoma of the pituitary gland was made with the possibility of an aneurysm. No other neurologic findings were found.

The patient was operated on May 11, 1953 and a craniotomy revealed a pituitary tumor (probably chromophobe). Because of cerebral edema and a stormy postoperative course the craniotomy was reopened next day, but the patient died later in the day. The pathologic report was nonspecific pituitary tumor. The pathologist thought it was an atypical chromophobe-type tumor.

Uveitis and tonsil infection

Dr. Fred C. Wallace presented the case of N. C., a 15-year-old Negress, in good general health, who was seen first on June 19, 1953, with a painful, red right eye of one week's duration.

Examination revealed an acute uveitis in-

volving both anterior and posterior segments of her right eye. The keratic precipitates were not typical of either granulomatous or nongranulomatous disease. Vision in this eye was 20/50 with pinhole. There was an intense vitreous haze and fundus detail was seen with difficulty. Disc hyperemia, vascular engorgement, and retinal edema were evident. The pupil was readily dilated with neosynephrine with fibrinous synechias being broken.

The left eye was totally blind, noninflamed, cataractous, and soft. The fundus could not be seen. The iris was bound down to the lens by synechias. A few old crenated keratic precipitates were present. No iris nodules were present.

A year previous to the present episode she had been treated for a uveitis of her left eye at the John Gaston and Eye, Ear, Nose and Throat Hospital eye clinics, going from one to the other over a period of months. Intramuscular milk, atropine, heat and topical cortisone were used during this period. Serology and tuberculin skin tests were negative at that time. Sight gradually diminished until at the present there is no light perception in her left eye.

Laboratory tests including agglutinations, serology, and several tuberculin skin tests were negative. A/G ratio and x-ray studies of chest and long bones were normal. General physical examination was normal as was a dental examination.

Because of the persistent, unrelenting course of her disease and in spite of the fact the clinical picture did not fit that of a granulomatous disease, she was given a month's course of streptomycin and PAS, with topical atropine and heat. This treatment had no apparent effect on the disease. Her right eye continued to be inflamed. At this time topical and oral cortisone were given with a remission which lasted only as long as she was on the drug.

Several courses of treatment were given but a relapse occurred each time following discontinuance of the drug. Chloramphenicol orally was given for two weeks without benefit. Typhoid-H antigen intravenously had been given intermittently without definite benefit.

After a re-check examination of her throat, it was decided to remove her tonsils; this was done three months after onset of the uveitis of her right eye. Previously her tonsils had not been thought an active focus of infection so the tonsillectomy was done with little hope of it helping her. Immediately upon removal of her tonsils a violent exacerbation of the uveitis of her right eye occurred. This suggestion that the source of trouble must have been her tonsils was borne out when the uveitis subsided completely within two weeks. This was approximately four months after onset of the disease in her right eye.

As the vitreous haze subsided a retinal separation was noted inferiorly and four retinal tears were seen in the superotemporal quadrant with retinitis proliferans at the operculum portions of the retina. The detachment increased until the inferior half of the retina was bullous. Vision was 20/100 with pinhole at this time. On November 5, 1953, the right eye was operated using surface and penetrating diathermy. Only a small amount of subretinal fluid was evacuated. At the present time she is wearing pinhole glasses and has a vision of 20/60. The retina is reattached.

The salient features of this case point out how important it is to classify, if possible, a uveitis. Time was lost in treating this case as a granulomatous disease. How difficult it is to assess possible foci of infection. Had this patient had a tonsillectomy at the beginning she probably would have sight in both eyes rather than one blind eye and one with reduced vision and a poor prognosis because of the possibility of further retinal separation, cataract, glaucoma, or phthisis.

Gumma of Orbit

Dr. Oscar Dahlene, Jr., reported a 46-year-old Negress with massive proptosis of the right eye. The patient stated that the right eye began to swell and bulge forward

on October 22, 1952, after getting dust in her eyes at cotton picking. She had a throbbing frontal headache, pain in the orbit, fever and chills. At admission to the John Gaston Hospital on October 27, 1952, she denied any residual pain and was not febrile. She also denied any knowledge of previous illness.

Examination revealed the right eye proptosed straight forward, massive edema of the lids and conjunctiva, and no motion of the globe. The cornea was clear and the pupil dilated, fixed, and with no reaction to light or accommodation. Visual acuity was questionable light perception, O.D., and 16/200, O.S. The orbital tissues were painless, did not pulsate, and had no bruit. The eye could not be forced backward into the orbit. The preauricular and submental nodes were enlarged but not tender. Intraocular pressure was: 32 mm. Hg, O.D., and 22 mm. Hg, O.S. (Schiøtz).

Fundus examination revealed a hyperemic disc, O.D., with blurred margins. The veins were dilated, sausage-shaped, tortuous, and constricted at the arteriovenous crossings. No hemorrhages or exudates were seen. There was a flat detachment of the retina nasally.

The left eye exhibited no abnormal findings.

The general examination showed nothing remarkable except a perforation of the nasal septum.

Papilledema, O.D., increased following admission. Ear, nose, and throat examination showed complete destruction of the septum and the right turbinates except for the posterior tips. No granulation tissue was seen.

Laboratory reported blood count and urinalysis normal, but a positive serologic test for syphilis. X-ray films showed destruction of the medial orbital wall and the previously noted loss of nasal bones.

A diagnosis of gumma of the orbit with inflammation was made and intensive treatment was begun. The patient was given 10 million units of penicillin over a period of 10 days, one gm. of Gantrisin every four hours while awake for four weeks, potassium-iodide drops in water, and multiple vitamins. Foreign-protein therapy was given with intravenous typhoid vaccine. The exposed cornea was protected with a conjunctival flap, antibiotic ointments, and a Buller shield.

The edema of the orbital tissues and proptosis began to recede in the second week of therapy and, on discharge four weeks after admission, the pupil had contracted and ocular motility had returned to a great extent. There was still some residual proptosis but the lids completely covered the globe in sleep. Light perception was questionable and never improved. The disc was pale.

The patient was seen at monthly intervals for several months and the proptosis gradually subsided, although the eye never returned to normal.

Daniel F. Fisher,
Secretary of Eye Section.

AMERICAN JOURNAL OF OPHTHALMOLOGY

Published Monthly by the Ophthalmic Publishing Company

Address original papers, other scientific communications including correspondence, also books for review to *Dr. Derrick Vail, 700 North Michigan Avenue, Chicago 11, Illinois;* Society Proceedings to *Mrs. Katherine F. Chalkley, Lake Geneva, Wisconsin.* Manuscripts should be *original copies,* typed in *double space,* with wide margins.

Exchange copies of medical journals should be sent to *Dr. F. Herbert Haessler, 561 North 15th Street, Milwaukee 3, Wisconsin.*

Subscriptions, application for single copies, notices of changes of address, and communications with reference to advertising should be addressed to the *Manager of Subscriptions and Advertising, 664 North Michigan Avenue, Chicago 11, Illinois.* Copy of advertisements must be sent to the manager by the 15th of the month preceding its appearance.

Change of address notice should be received not later than the 15th of the month prior to the issue for which the change is to go into effect. Both old and new addresses should be given.

Author's proofs should be corrected and returned within forty-eight hours to the *Manuscript Editor, Mrs. Katherine F. Chalkley, Lake Geneva, Wisconsin.* Twenty-five reprints of each article will be supplied to the author without charge. Additional reprints may be obtained from the printer, the George Banta Publishing Company, 450-458 Ahnaip Street, Menasha, Wisconsin, if ordered at the time proofs are returned. But reprints to contain colored plates must be ordered when the article is accepted.

TOXOPLASMOSIS TESTS

It is very difficult, almost impossible, to find a clinical laboratory to perform the cytoplasm modifying antibody test (the dye test of Sabin and Feldman) for toxoplasmosis. The Communicable Disease Center at Chamblee, Georgia, performs the tests only in suspected cases of congenital infection. Other laboratories, such as the National Institute of Health at Bethesda, Maryland, Dr. Harry Feldman's laboratory at Syracuse, New York, Dr. Michael Hogan's Proctor laboratory at the University of California, are all curtailing this activity for one reason or another.

Several factors contribute to discouraging serologists and their laboratories from performing this test. Among these are the orig-

inal and in some instances the persistent statements by various authorities deprecating the usefulness of the test in cases of ocular disease: (1) That up to 40 percent of the general population have antibodies to Toxoplasma; (2) that the frequency of toxoplasmosis as a cause of ocular disease in adults is unknown; (3) that an increasing dye test titer (a fourfold increase) is necessary before reliance can be placed upon the test; (4) that a single dye test is of no value; (5) that a good clinical laboratory cannot perform this test; (6) that there is not enough demand for the test to justify that laboratories have it available; (7) that we are only justified in performing the test for patients with congenital toxoplasmosis; (8) that we are not justified in performing the test on adults with ocular disease; (9) that the test is too dangerous, too time-consuming, and doesn't give enough information to justify it.

On the basis of my own[1] experience with the test, together with that of Wilder,[2] Woods,[3] Ryan et al.,[4] Passmore,[5] Jacobs,[6] and Frenkel,[7] indicating that 25 percent to 40 percent of retinochoroiditis in adults is probably due to Toxoplasma infection, it would seem that the time has come to re-evaluate this diagnostic aid and to make use of it to help determine the etiology of granulomatous uveitis. After other causes of uveitis have been ruled out, in order to complete a clinical survey, both the skin test and the dye test for toxoplasmosis should be utilized. Retinochoroiditis or granulomatous uveitis results from the release of encysted Toxoplasma organisms in the retina which incite an endopthalmitis either adjacent to an old healed area or as an entirely new retinitis lesion. This process may occur years after the initial infection and when the antibody titer is low. Although it can be a residuum of congenital toxoplasmosis and the organism may persist encysted for years, its mode of transmission is still unknown.

The cytoplasm modifying antibody test for toxoplasmosis is tedious, time-consuming, and not without some danger for those performing it. Because laboratory infections have occurred, great care must be used in the frequent mouse transfers that are required to produce a sufficient number of the fresh live organisms for the test. The antibodies against Toxoplasma in the patient's serum modify the staining reaction of the organisms with methylene blue dye. The end-point of the test is the titer of the patient's serum which will inhibit staining of 50 percent of the Toxoplasma organisms. The stained and unstained organisms on quite a few slides have to be examined to determine this end-point. A clinical laboratory having facilities for animal work and a competent serologist can do the test. After other causes for uveitis have been ruled out a single positive test is significant. An increasing titer (a fourfold increase) may be of value, but even 1:32 or 1:16 titers in single tests are meaningful especially if confirmed by a positive intradermal reaction. In adults with granulomatous uveitis, the titer is often low. Jacobs[6] found a 1:64 titer in a patient whose enucleated eye revealed live Toxoplasma organisms.

Even though in some areas as high as 40 percent of the general population have antibodies to Toxoplasma, statistical correlations between antibodies and chorioretinitis have been obtained (Frenkel[7] and Woods et al.). These figures were based on spot checks in a few cities. While the dye test does not give a definitive diagnosis, it does indicate that toxoplasmosis may be considered in the differential diagnosis. If it is positive, we do not conclude that Toxoplasma is responsible for the uveitis unless we have ruled out other causes.

The demand for the test is out of all proportion to the facilities for its performance. Requests from all parts of this country and from outlying areas have been made upon our laboratory (The South Bend Medical Foundation) and similar experience has been encountered by all other laboratories where the test is available. To limit the test

to cases of congenital toxoplasmosis, as is now done by the Communicable Disease Center on the recommendation of an expert committee that met in 1952, is not a valid limitation when so many adults have been found to have granulomatous uveitis which may be due to this disease. Many adults seem to have their initial attack of uveitis in the third, fourth, and fifth decades. This may be from a congenital infection but is not necessarily so.

The importance of a clinical diagnosis of toxoplasmic granulomatous uveitis has been intensified by the remarkable response to systemic antitoxoplasmosis therapy during the acute uveitis attack. Untreated toxoplasmic retinochoroiditis is prolonged, severe, and destructive, but when pyrimethamine and sulfadiazine are used, the response is almost dramatic. The endopthalmitis subsides, the vitreous clears, and the vision improves within a few days. This treatment neither cures the disease nor prevents recurrence, but it allays the acute inflammatory process. The use of pyrimethamine and sulfadiazine is fraught with danger and should never be prescribed unless toxoplasmosis is indicated as the cause of the granulomatous uveitis. Because thrombocytopenia and leukopenia may follow its administration, frequent and repeated blood studies should be made and used if these drugs are administered. Until other possible causes for the uveitis have been ruled out and until a presumptive diagnosis by either a positive intradermal or dye-test reaction has been established their use would not be justified.

Although no report has yet been published, I have learned that the Parasitology and Tropical Medicine Study Section, Division of Research Grants, National Institutes of Health, last December sponsored a meeting of experts on toxoplasmosis to discuss the role of Toxoplasma in ocular disease. It is understood that a report of that meeting will be published, and that the report does not advocate the provision of routine tests for toxoplasmosis in cases of adult granulomatous uveitis. I have no sympathy for such a decision. Qualified clinical laboratories should be encouraged to perform the dye test for ocular toxoplasmosis so that this diagnostic aid will be more readily available. There have been no definitely false positives. The so-called positive reactions attributed to Sarcocystis, Trichomonas, and Trypanosoma cruzi were in such low titers that they are not considered reliable, particularly since infection with Toxoplasma was not ruled out. For many laboratories the performance of the test would be expensive and some subsidy may be necessary to the laboratories to make the cost inexpensive enough for the ordinary patient. Until some simpler method of diagnosing toxoplasmosis is found this test should be available for a complete etiologic survey for patients with granulomatous uveitis.

J. V. Cassady.

References

1. Cassady, J. V., and Culbertson, C. S.: The etiology of retinochoroiditis: Importance of the dye (methylene blue) cytoplasm modifying antibody test for toxoplasmosis. Arch. Ophth., **54**:28, (July) 1955.

2. Wilder, H. C.: Toxoplasma chorioretinitis in adults. Arch. Ophth., **47**:425, 1952; **48**:127-136, 1952.

3. Woods, A. C., Jacobs, L., Wood, R. M., and Cook, M. K.: A study of the role of toxoplasmosis in adult chorioretinitis. Am. J. Ophth., **37**:163-177, (Feb.) 1954.

4. Ryan, R. W., Hart, W. M., Culligan, J. J., Gunkel, R. D., Jacobs L., and Cook, M. K.: Diagnosis and treatment of toxoplasmic uveitis. Tr. Am. Acad. Ophth., **58**:867-884 (Nov.-Dec.) 1954.

5. Passmore, J.: Present status of ocular toxoplasmosis. Presented in Ophth. Seminar and to be published as Ophth. Seminar Tr. 1955, Walter Reed Army Medical Center, Washington, D.C.

6. Jacobs, L., Fair, J. R., and Bickerton, J. H.: Adult ocular toxoplasmosis: Report of a parasitologically proved case. Arch. Ophth., **52**:63-71 (July) 1954.

7. Frenkel, J. K., and Friedlander, S.: Toxoplasmosis. Dept. of Health, Education, and Welfare, U. S. Public Health Serv., 1952. Bull. 141. Frenkel, J. K.: The pathogenesis of toxoplasmosis. Am. J. Trop. Med. & Hygiene, **2**:No. 3 (May) 1953.

GLAUCOMA SIMPLEX

Credit for the first recognition of the cupped disc in glaucoma—in 1855, just 100 years ago—belongs to Adolph Weber. With indirect ophthalmoscopy he noted that a movement of the convex lens caused vessels at the edge of the disc to move faster and ahead of those in the bottom, thereby producing an increased separation. This parallax was verified by von Graefe and Förster the same year and corroborated later by direct ophthalmoscopy using the improved instrument of Helmholtz having minus lenses in the Rekoss disc. Finally, in 1858, H. Müller demonstrated the glaucomatous cup in histologic sections of eyes enucleated for absolute glaucoma.

The word "glaucosis" appears in the writings of Hippocrates and for centuries glaucoma was identified with incurable blindness —gutta serena. Mackenzie in the first edition of his famous textbook (1830) emphasized "preternatural hardness" of eyes with glaucoma and detailed the means then available for the differential diagnosis of glaucoma from cataract. In the 1854 edition, published before the ophthalmoscopic findings in glaucoma were known, he described glaucoma as a single entity with six stages. The first two apparently referred to noncongestive glaucoma; the third stage was congestive glaucoma; the fourth, absolute glaucoma; and the last two delineated the sequential phases of glaucomatous degeneration. The spontaneous arterial pulsation revealed by the ophthalmoscope (von Graefe, 1854) which indicated that the intraocular pressure was then higher than the diastolic arterial pressure, followed by the discovery of the cupped disc, convinced the dubious conclusively that the essential factor in glaucoma was ocular hypertension and that all characteristics of the disease, subjective and objective, stemmed from it. Von Graefe propounded a clinical classification of the glaucomas that remained unchallenged until the past quarter century. He originally considered noncongestive glaucoma to be a distinctive form and labelled it "amaurosis with excavation of the disc." Though von Graefe substituted later the designation, glaucoma simplex, proposed by Donders in 1862, he personally regarded the condition as a form of secondary glaucoma due to an obscure intraocular cause effecting somehow a permanent stimulus to increased tension.

Donders found in noncongestive glaucoma support for a unified conception of glaucoma. As in this type the first manifestation of the disease was increased tension only, he assumed that congestion is not an integral part of the glaucomatous process but a complication that may not even occur. He therefore regarded glaucoma without congestion as the primordial form of glaucoma and hence named it "glaucoma simplex."

Mackenzie, von Graefe, and Donders believed that the glaucomatous tension resulted from excessive production of fluid within the eye. But ophthalmic thought veered sharply to faulty excretion as the cause after Adolph Weber and Max Knies, in 1876, independently noted adhesions of the iris base to the cornea in their histologic sections of enucleated eyes with congestive glaucoma. This view was elaborated by Priestley Smith and its validity for the primary glaucomas has been established by tonography. Thomas Henderson, in 1907, first implicated the trabecular area. From his microscopic sections he held that sclerosis of the fibrous structures comprising the pectinate ligament impedes access of the aqueous to Schlemm's canal. Dominated by the supposition then prevalent that all primary glaucomas were but modifications of the same morbid process he interpreted anterior peripheral synechias when present as a secondary complication.

The unity of the primary glaucomas was questioned by Raeder in 1923 and by Bengt Rosengren in 1930 both of whom noted that an abnormally shallow anterior chamber was characteristic of the glaucoma, with subacute, acute, or recurrent episodes, while in glaucoma simplex the chamber depth simply

corresponded to normal biologic variations. To Otto Barkan gonioscopy was a better criterion for differentiation and he proposed in 1938 the separation of primary adult glaucoma into two entities designated according to the gonioscopic picture as *narrow angle* (called alternatively iris block or angle closure) and *open angle* (or trabecular).

Open-angle glaucoma (glaucoma simplex) is four times as common as acute glaucoma but much less often recognized. The disease is asymptomatic and probably 80 percent of affected persons are unaware of its presence. The rise of tension is insidious, gradual, and progressive. In its uncomplicated form this type is not associated with any congestion, corneal edema, or pain. Detection depends on the diagnostic alertness of the examiner. Historically the glaucomatous cup gave the first indication of this entity in 1855 and even now this ophthalmoscopic finding gives the first intimation of the disease in 60 percent of cases thus diagnosed according to the data of Lemoine at the Massachusetts Eye and Ear Infirmary and of Lloyd at Oxford.

Soelberg Wells in his textbook (1868) says: "Patients too frequently suppose that the increasing weakness of sight is simply due to old age. The increase of tension varies greatly; it is of consequence, therefore, to examine such eyes at different periods of the day." Maslenikow in 1904 noted that the most favorable time to elicit raised tension is before the patient has stirred from bed. In 1862, Bowman devised a simple notation for recording tactile tension. After the advent of the Schiøtz tonometer in 1905, experienced ophthalmologists discovered that the digital estimation of ocular tension erred significantly in one third of cases. It is now recognized that "There is no substitute for tonometry in the detection of asymptomatic glaucoma and only with a tonometer can the early diagnosis be made." (Gundersen.)

The visual field was first used for diagnostic purposes by von Graefe. In 1889 Bjerrum introduced the campimeter and quantitative perimetry. The field defects of glaucoma are, in order of progression: vertical enlargement of the blindspot, baring of the blindspot (Sinclair, 1906), Seidel's sickle scotoma, Bjerrum's arcuate scotoma succeeded as the process advances by Roenne's nasal step, and general contraction to the macular area and a temporal island, the latter disappearing last. The earliest findings are reversible. At the initial examination of 2,500 glaucomatous eyes Lemoine found that the tension was 40 mm. Hg or more in 70 percent and that a field defect was present in nearly 90 percent.

Mass screening of 40,000 employees, 40 to 65 years of age, by Brav and Kriber disclosed that 2.24 percent had unrecognized glaucoma. The routine tests included determination of visual acuity, ophthalmoscopy, and tonometry. Suspected cases were further examined by a 24-hour tension curve, provocative tests, and visual field studies. A tension of 28 to 32 mm. Hg was considered borderline; over 32 mm. Hg or with a difference of 6.0 mm. Hg tension in the two eyes and with only early field defects was labelled early glaucoma; while a tension over 40 mm. Hg or with advanced field defects was designated definite glaucoma.

In 1928 Schmidt introduced the water-drinking test of the internist Marx as a provocative test for glaucoma. Positive results occur to a similar extent in narrow-angle and open-angle types. In 1954, Leydhecker introduced a new test, the subconjunctival injection of Priscoline, which he finds is twice as reliable as the water test. The Priscoline test is likewise applicable to both types of primary glaucoma. The intense vasodilatation causes a reflux of blood in the aqueous veins and thus impedes outflow. After the application of a local anesthetic to the superior bulbar conjunctiva he injects one ampule of Priscoline (10 mg. in 1.0 cc. distilled water), and tonometry follows in

15, 30, 60, and 90 minutes. The average increased tension in normal eyes is 5.0 mm. Hg. A rise of 11 to 13 mm. Hg is presumably pathologic and of 14 mm. Hg or more certainly so. The injection is painless and elevated tension can be neutralized rapidly by the instillation of epinephrine 1:1,000.

The mydriatic provocative tests give a positive result in narrow-angle glaucoma only. Conversely, tonography shows an increased resistance to aqueous flow in open-angle glaucoma but the resistance to flow is normal in the narrow-angle type except during a hypertensive crisis. According to Blaxter the simpler bulbar pressure test gives a higher percentage of positive results in early cases of open-angle glaucoma than tonography.

The separation of the primary glaucomas into narrow-angle and open-angle entities has had the practical value of emphasizing certain contrasts in the medical and surgical management of the two distinctive syndromes.

James E. Lebensohn.

Albert C. Snell, Sr.

OBITUARY

ALBERT C. SNELL, SR.
(1871-1954)

Ophthalmologists, lawyers, workmen's compensation courts, the high ranks of official medicine of the American Medical Association, and the American Academy of Ophthalmology and Otolaryngology have lost a very real friend in the death of Dr. Albert C. Snell, Sr., on December 11, 1954.

He was born in Geneva, New York, May 18, 1871, the son of Marvin and Sarah Snell. He was graduated from Cornell University, and received his degree in medicine from the University of Pennsylvania in 1898. He served one year of residency in Wills Eye Hospital where his son, Albert C. Snell, Jr., was later to serve. He then became an assistant at Moorfield's Hospital in London. He started to practice ophthalmology in Rochester, New York, in 1900, and early became interested in the problems of school children and the early detection of refractive errors. In World War I he served as chairman on Unit 42 of the Medical Advisory Board, and in World War II was consultant to the same board.

Some of us remember him most as an eager, informed, kindly leader in the field of industrial ophthalmology. He was chairman of the first Joint Committee on Industrial Ophthalmology established by the Academy in 1940. His book *Medical-Legal Ophthalmology* is still a standard text and appears in almost every compensation case dealing with eyes. He was a courageous individual, guided by high principles of ethics, doing what he considered right and honorable for a medical person whose first interest was always the patient. He never hesitated to admit mistake, or that he was wrong in his interpretation. His generous give-and-take was an inspiration to all.

In 1953 he was honored by the Joint Committee on Industrial Ophthalmology, receiving the Award of Merit on the basis of his tremendous contribution to industrial ophthalmology. He has written over 50 papers, being particularly interested in the relationship between macular activity and macular perception. He was on the American Medical Association Committee for computation of percent loss of visual efficiency in eye injuries which, until the 1955 section of the American Medical Association, remained a standard and which, even now, has really only been supplemented, no drastic change having been made.

As chairman of the Section on Ophthalmology of the American Medical Association, and chairman of many important committees, as well as a member of the council of the American Academy of Ophthalmology and Otolaryngology, his influence was great. So also was it in Rochester, as ophthalmologist of the University of Rochester School of Medicine and lecturer at the Strong Memorial Hospital. The Rochester Academy of Medicine awarded him the Albert David Kaiser Medal as a tribute to "Eye physician and surgeon, author, industrial ophthalmologist, and citizen."

At the Memorial Service in Rochester his favorite poem was quoted and this also would seem a fitting place to point to what really might be called his creed and philosophy.

A Doctor's Prayer

O God, to Thee I make this prayer,
And from an humble heart I pray;
Guide with Thy wondrous love and care,
My hand, in this its work today.

Grant me the light to see and do
That which is wisest and best;
Grant that Thy Spirit may inbue
My task, with blessings manifest.

Not for myself, O Lord, I pray
These blessings (if it be Thy will)
But for the one who trusts today
Thy guidance of my skill.

—Found on the cover of a *Physician's Medical Journal*, 1740.

He lived a happy life, and a very useful one. He gave much, and he felt that he received much. We are all better ophthalmologists through knowing him, and stronger individuals through loving him.

Hedwig S. Kuhn.

CORRESPONDENCE

Preservatives for solutions

Editor,
American Journal of Ophthalmology:

We have read with great interest the review by Dr. C. A. Lawrence entitled "Chemical preservatives for ophthalmic solutions," published in the March, 1955, issue of The Journal. Dr. Lawrence concludes from his study of the literature that chlorobutanol, phenylmercuric nitrate, and benzalkonium chloride all are of value as such preservatives. We are very well acquainted with Dr. Lawrence's own valuable investigations concerning the quaternaries as antiseptics, to which unfortunately he does not refer. In a dynamic field such as antiseptics, one must be careful in reviewing the literature to ascertain which data experience has shown to have been superseded or outmoded. This is particularly important in a review that is so widely read by persons not conversant with the many pitfalls inherent in the evaluation of antiseptics.

Our objections to the use of benzalkonium and other quaternaries either as antiseptics, or as preservatives, have been stressed and documented elsewhere, and are well known to most ophthalmologists. They have recently been confirmed by a study that apparently appeared after Dr. Lawrence's review was written (Murphy, J. T., Allen, H. F., and Mangiaracine, A. B.: Preparation, sterilization, and preservation of ophthalmic solutions. Arch Ophth., **53**:63-78, 1955). It is not our purpose to repeat these objections here. However, we would like to point out several general areas in

this review that require more discussion, areas in which we feel that all ophthalmologists and pharmaceutical chemists having intimate contact with the problem, will react similarly.

For example, the term "contaminated" (sic) ophthalmic solutions, not to mention other phrases Dr. Lawrence writes in quotes, tends to dismiss a little too lightly a problem concerning which many of us have become painfully aware. In a similar vein, Dr. Lawrence states, apparently on the basis of published reports, mainly in pharmaceutical journals, that our objections concerning their inactivation, under so many conditions, are of little practical importance, although he does not deny these objections. As a matter of fact, important and disastrous instances resulting from such inactivation, including episodes where organisms as virulent as Pseudomonas aeruginosa (B. pyocyaneus) proliferated in aqueous solutions of benzalkonium, are known to many interested in the subject. Yet, since such occurrences are rarely publicized for obvious reasons, one can understand why a review of the literature would fail to include these pertinent facts. Furthermore, in regard to the use of alcoholic solutions of the quaternaries (tincture of Zephiran), as well as mercurial tinctures, there is evidence indicating that their antiseptic value depends on their alcohol-acetone content, and that a similar concentration of alcohol alone is even better as an antiseptic (Price, P. B.: The meaning of bacteriostasis, bactericidal effect, and rate of disinfection. Ann. New York Acad. Science, **53**:76-90, 1950).

The major reason we were impelled to write this letter has recently become a matter of the greatest importance to ophthalmologists: the sterilization of tonometers. Dr. Lawrence refers to the use of benzalkonium for routine sterilization of tonometers implying that the drug has antiviral properties. In so doing, he unfortunately aids in the perpetuation of an ineffective and outmoded procedure which by now should be discarded. As many ophthalmologists are aware, the numerous episodes where serious infections with the virus of epidemic keratoconjunctivitis occurred via the tonometer despite the use of benzalkonium, have highlighted the shortcomings of this drug for the purpose of such sterilization. At the present time, the only safe method of preventing the transmission of viral infections via the tonometer is heat sterilization, either with the use of the actual flame or electric heating devices.

A similar but less obvious situation would now appear to arise in advocating the use of aqueous solutions of benzalkonium for surgical instrument sterilization and optical appliances.

We appreciate the numerous references to our work in Dr. Lawrence's review. However, we feel that using one of them (Theodore, F. H.: Silent dacryocystitis. Arch. Ophth., **40**:157-162, 1948) which deals neither with ophthalmic solutions nor with the antiseptic value of Zephiran as a testimonial for this drug, is quoting entirely out of context.

In closing, we would like to warn against the term "self-sterilizing" ophthalmic solutions which, like Dr. Lawrence, we do not endorse nor ever use. In this connection we beg permission to quote from our Report to the Council on Pharmacy and Chemistry of the American Medical Association (J.A.M.A., **152**:1631-1633, 1953) dealing with this subject:

"The choice of the proper preservative is of the greatest importance. It must be realized, however, that no antiseptic available at present as a preservative for ophthalmic solutions can be relied on. Preservatives that are generally considered reliable may be found inadequate on occasions, such as in the event of particularly gross contamination of the antiseptic or when inactivation of the antiseptic occurs. Thus, the addition of preservatives to solutions not prepared under sterile precautions, as has been suggested by some investigators, can never serve as a

substitute for sterile preparation of these drugs."

(Signed) Frederick H. Theodore and
Robert R. Feinstein, New York.

DR. LAWRENCE'S REPLY

Editor,

American Journal of Ophthalmology:

Dr. Theodore and Mr. Feinstein have criticized some portions of my objective review of the literature on "Chemical preservatives for ophthalmic solutions." Their objections appear to take the form of a condemnation of antiseptic agents in general and of quaternary ammonium compounds in particular. This I feel is unwarranted in the light of the available evidence.

The readers of THE JOURNAL undoubtedly recognize that sole reliance for prevention of contamination and infection should not be placed on chemical preservative agents; however, it should be stressed that chemical preservative agents properly used have a definite place in the preparation and use of ophthalmic solutions and in maintaining sterility of ophthalmologic devices. The agent of choice depends upon a number of factors which must be weighed carefully in each case. This was presented in my article.

During the course of the preparation of my review article it became evident that a carefully controlled laboratory investigation should be made of the comparative efficiency of the chemical agents most frequently used as preserving agents in ophthalmic solutions. That work, involving a study of numerous strains of *Pseudomonas aeruginosa*, has been completed and is in press. Thus it will be seen that I have not "dismissed lightly" the problem of "contaminated" ophthalmic solutions. It is hoped that this discussion will stimulate others to undertake similar investigations in this field.

(Signed) C. A. Lawrence,
Los Angeles.

BOOK REVIEWS

MEDICAL PROGRESS. *Edited* by Morris Fishbein, M.D. New York, McGraw-Hill Book Company, 1955. 322 pages, index. Price: $5.00.

This book, containing a review of medical advances during 1954, is one of a series published annually under the editorship of Morris Fishbein. There are 28 contributors, each of whom has prepared a chapter on the most important developments in his particular field. Dr. Manuel L. Stillerman of the University of Illinois is the author of a 10-page discussion on ophthalmologic progress. The subjects which he has included are: retrolental fibroplasia, infantile glaucoma, the use of Diamox in the treatment of glaucoma, and the use of radioactive phosphorus (P^{32}) in the detection of intraocular neoplasms.

The volume is of value to anyone who wishes, with a minimum of effort, to keep abreast in the fields of medicine whose current literature is too vast to permit complete perusal.

William A. Mann.

DISEASES OF THE EYE. Published by Roche Products Limited, London, 1955. No. 1. 14 pages.

The first folio of an *Atlas of Ophthalmology* published by Roche Products Limited (Pharmaceuticals) has just appeared. The beautiful illustrations that it contains were prepared by the Medical Illustration Department in association with Moorfields, Westminster, and Central Eye Hospital, all of London. There are 30 colored illustrations, all of the fundus, beginning with the normal and including arteriosclerosis, vascular hypertension, arterial and venous occlusions, and miscellaneous systemic retinal conditions. The accompanying text is most adequate.

Roche Products plans to bring out six numbers during this year which will subse-

quently be made available as a single volume. Roche is performing a great service to ophthalmologists, for colored illustrations are very expensive and few authors are able to carry the load. We look forward to the final volume.

Derrick Vail.

RECEPTORS AND SENSORY PERCEPTION. By Ragnar Granit, M.D., Director Nobel Institute for Neurophysiology, Stockholm. New Haven, Yale University Press, 1955. 369 pages, 145 figures, bibliography, and index. Price: $5.00.

This volume, an amplification of Granit's recent Silliman lectures at Yale University, aims to present from the basis of electrophysiologic research a comprehensive synthetic view of the organization of the sensory message in both its peripheral and central aspects. It thus complements a previous Silliman Memorial Lecture volume—Sherrington's, *The Integrative Action of the Nervous System*.

With admirable acumen and perseverance Granit has found in electrophysiology an objective basis for the analysis of visual and other sensations which both confirm and amplify the conclusions obtained through subjective methods. The message in individual nerve fibers has the character of a simple frequency code. The sensory pathway, however, may or may not evoke perception; for example, we are not aware of our pupillomotor reflexes.

The Yale University Press is to be commended for producing, as is its custom, a fine publication at a relatively low price. The work is primarily directed to the neurophysiologist; for the ophthalmologist, Granit's previous publication, *Sensory Mechanisms of the Retina* (reviewed in THE JOURNAL, 30:1446 [Nov.] 1947) is more directly useful.

James E. Lebensohn.

CONTRIBUTION TO THE STUDY OF HETEROCHROMIAE. By George D. Georgiades. Thessalonike, Greece, 1953. 140 pages. Price: Not listed.

Based as it is on 10 years of observation and study of heterochromia iris, the wealth of material contained in this monograph can hardly be summarized. The book is divided into five sections:

The first includes a short review of the present concepts on the anatomy, physiology, and biomicroscopy of the iris and the author's tests in the study of heterochromiae, such as physical and laboratory examinations, pharmacodynamic test on the iris, X-ray examination of the spine, 10 percent intravenous fluorescein to test permeability of the capillaries, paracentesis with microscopic examination of the aqueous, and histologic examination of the iris.

The second and third sections are devoted to partial and complete hyperchromia and hypochromia of the iris, congenital or acquired. The fourth part covers the complex heterochromia-cataract syndrome which is classified into five main groups: (1) heterochromia-complicated cataract, (2) heterochromia-traumatic cataract, (3) hypochromia-cataract, (4) Fuchs' syndrome, and (5) hyperchromia-cataract. The author reports five cases of the latter group which are not specifically described in the literature.

A great part of the section is devoted to Fuchs' syndrome and 52 cases are reported in detail; in four it was present bilaterally and almost equally divided between males and females. The most significant findings in the majority of cases were acceleration of permeability of the capillaries after the Amsler-Huber fluorescein test, hyaline degeneration, thickening of the walls, sclerosis of the vessels and stroma of the iris, and increased pigmentation. The author submitted 38 out of the 52 cases to X-ray examination of the spine and found definite changes in the cervical spine in 21 (55 percent): (a) arthrosis and osteophytes especially between

C4, C5, and C6; (b) total or segmental rigidity of the cervical rachis; (c) kyphosis; and (d) hypertrophy of the seventh transverse process.

The last section is devoted to pathogenesis of heterochromia and the author's experimental work with rabbits.

A summary follows and concludes that Fuchs' syndrome is of a vascular nature due to disturbances of thalamic and vasomotor centers.

The monograph is beautifully printed with several illustrations, reproductions of X-ray films and microphotographs, and includes at the end a comprehensive summary in French and an up-to-date bibliography.

Manos A. Petrohelos.

CLINICAL MANUAL ON ANISEIKONIA. By Robert E. Bannon. Buffalo, American Optical Co. (Instrument Division), 1955. 120 pages, 41 figures. Paperbound. Price: $1.00.

Differences in the relative size of the images of the two eyes was discussed by Donders in his text of 1864 and by many ophthalmologists since. Such differences if normal are now called disparities; if abnormal, "aniseikonia"—a term supplied by Lancaster. Ames and his associates at the Dartmouth Eye Institute are responsible for developments that led to successive instruments for measuring aniseikonia—the ophthalmoeikonometer the simplified standard eikonometer and, finally, the present office model space-eikonometer.

All tests for aniseikonia require that the patient have binocular vision and stereopsis. An aniseikonic correction is probably indicated when monocular occlusion relieves symptoms in the absence of significant heterophoria. An aniseikonic correction will probably be of more aid to the young than to the old, to anisometropic cases than isometropic cases, and when the muscle balance is essentially normal than when definitely abnormal. Patients are more likely to secure relief with a meridional aniseikonic correction between one and two percent than when the value is higher or lower. Bannon estimates that three percent of asthenopic patients have clinically significant aniseikonia. From the data of the Dartmouth Eye Institute aniseikonic corrections apparently gave subjective relief to two out of three such cases. A valuable feature of this excellent booklet is the detailed analyses of 25 representative cases.

James E. Lebensohn.

THE HEBREW MEDICAL JOURNAL. Edited by M. Einhorn, M.D., New York, N.Y., 1954, vol. 2. Bilingual—English, 64 pages; Hebrew, 95 pages.

In commemoration of the 750th anniversary of the death of the celebrated Maimonides, the bulk of this volume is devoted to his career. Maimonides (1135-1204) was born in Cordova, Spain; lived in an Arabic world and absorbed from Arabic teachers all the knowledge of his time. His success as a physician was notable. It was said that Galen cured only the body but Maimonides cured both body and mind. The crusading Richard the Lion-Hearted, while in Palestine, invited Maimonides to become his court physician but Maimonides refused out of loyalty to Saladin. His book, *On Hygiene*, is still timely despite the advances since made. He urged moderation: "One should never eat unless one is hungry and one should never drink unless one is thirsty." In his medical treatises he opposed strong drugs and observed that better results were achieved by building up the patient's health and leaving the rest to nature.

James E. Lebensohn.

ABSTRACT DEPARTMENT

EDITED BY DR. F. HERBERT HAESSLER

Abstracts are classified under the divisions listed below. It must be remembered that any given paper may belong to several divisions of ophthalmology, although here it is mentioned only in one. Not all of the headings will necessarily be found in any one issue of the Journal.

CLASSIFICATION

1. Anatomy, embryology, and comparative ophthalmology
2. General pathology, bacteriology, immunology
3. Vegetative physiology, biochemistry, pharmacology, toxicology
4. Physiologic optics, refraction, color vision
5. Diagnosis and therapy
6. Ocular motility
7. Conjunctiva, cornea, sclera
8. Uvea, sympathetic disease, aqueous
9. Glaucoma and ocular tension
10. Crystalline lens
11. Retina and vitreous
12. Optic nerve and chiasm
13. Neuro-ophthalmology
14. Eyeball, orbit, sinuses
15. Eyelids, lacrimal apparatus
16. Tumors
17. Injuries
18. Systemic disease and parasites
19. Congenital deformities, heredity
20. Hygiene, sociology, education, and history

1

ANATOMY, EMBRYOLOGY, AND COMPARATIVE OPHTHALMOLOGY

Aurell, G., and Holmgren, H. **On metachromatic staining of corneal tissue and some observations on its transparency.** Acta opht. **31**:1-27, 1953.

The literature on corneal collagen and its characteristics is reviewed, and the data of the authors' investigations on metachromasia, refractive index, and the capacity of swelling of the corneal collagen are reported. The material comprises corneas of cows and swine, and of fetuses of man, rats, mice, rabbits and guinea pigs. The data show that only corneal collagen absorbs metachromatic substances (corneal mucoid, or at least its metachromatic component, and heparin) to a significant degree; other types of collagen absorb these substances in very much smaller amounts. This characteristic of corneal collagen distinguishes it from the ordinary collagen of tendons. The mucoid substance is present within the corneal fibrils as well as between them. The pronounced capacity of swelling of the cornea in water is a characteristic of the collagen of the stroma. The examination of the cornea of fetuses showed that the metachromatic substance is present in the cornea of all animals. It first appears about the inner part of the cornea, and is not found distributed over the entire cornea until the time when the animal begins to use its eyes. In the study of the refractive index it was found that the cornea remains transparent within much wider limits of the refractive index of the permeating fluid than is the case with other collagenous organs. This characteristic is lost when the fibrils of the stroma are separated by force. (7 figures, 61 references) Ray K. Daily.

Busacca, Archimède. **Remarks on recently reported studies on lymphatics of the human bulbar conjunctiva.** Arch. d'opht. **15**:4-9, 1955.

Busacca refers to his biomicroscopic studies published in 1948 on the lymphatic vessels of the bulbar conjunctiva which he rendered visible by subconjunctival injections of trypan blue. In these earlier studies he pointed out the erroneous conclusions of previous investigators, notably Cuénod and Nataf, and Knuesel and Vonwiller. He refers to the communication of Nataf and Delon in 1953 in which a claim is made for the discovery of the lymphatics which he, Busacca, had already fully

described. Busacca then analyzes the work of Knuesel published in 1954, confirming in all details this author's findings but vigorously disputing his interpretations. (2 figures, 3 references)

Phillips Thygeson.

Sugiura, S. **Electron-microscopic studies of the vitreous body.** Acta Soc. Ophth. Japan **59**:564-571, June, 1955.

Two kinds of fibers were demonstrated in the vitreous of some animals by means of the electron microscope. One is a smooth fiber of 200Å width and the other is a cross-striated fiber of 250Å width. The former is predominant and the ratio of the former to the latter is 26:1. A small number of collagen fibers of 500 Å width is also demonstrated. The illustrations are beautiful. (16 figures, 13 references)

Yukihiko Mitsui.

de Toledo Plaza, Plinio. **Ciliary muscle in the dog.** Rev. brasil. oftal. **14**:59-100, March, 1955.

This paper is a thesis prepared as a requirement for a teaching appointment. The purpose is to investigate the structural modifications in the ciliary muscle of dogs under nervous and medicamentous influences. The author briefly reviews the most important papers written about the ciliary muscle of the dog.

In his experimental study he used four groups of material. In the first one were normal dog eyes. The second group was formed by 15 preparations of ciliary muscle fixed in Susa (injected into the anterior chamber) after prolonged stimulation of the cervical sympathetic on the same side. The third group consisted of preparations of ciliary muscle fixed with Susa 45 minutes after a subconjunctival injection of pilocarpine. The fourth and last group was formed by eyes fixed with Susa 60 minutes after a subconjunctival injection of atropine sulfate.

The author concludes that the structural changes observed in the ciliary muscle seem to be proof of sympathetic innervation of the muscle. Atropine produces the same type of structural change in the disposition of the muscle fibers as sympathetic excitation. Pilocarpine, on the other hand, produces changes opposite to the ones produced by atropine. In the induced midriasis, either by sympathetic stimulation or atropine, the first layer of the most external fibers, formed by longitudinal fibers, becomes dislocated in a transverse direction. At the same time the second and third layer of deep fibers, which have an oblique disposition, show a definite increase in the network of their fibers. During miosis produced by pilocarpine, the external longitudinal fibers flatten their anterior ending, adopting the form of a V. (23 figures, 29 references)

Walter Mayer.

Wolter, J. Reimer. **Morphology of the sensory nerve apparatus in striated muscle of the human eye.** A.M.A. Arch. Ophth. **53**:201-207, Feb., 1955.

This is a histologic and morphologic study of the sensory organs of the extraocular muscles with 13 photomicrographs. Six distinctly different sensory end organs are described. These differ from those found in other types of skeletal muscle. Definite functions for these organs have not yet been determined, except for their close correlation with capillaries. (13 figures, 23 references) G. S. Tyner.

Wolter, J. Reimer. **Histologic character of connection between Bruch's membrane and choriocapillaris of human eye.** A.M.A. Arch. Ophth. **53**:208-210, Feb., 1955.

A brush or root-like connective tissue between the choriocapillaris and Bruch's membrane is described. It is considered to be an anchor mechanism to assure a firm connection between these two structures. (4 figures, 10 references) G. S. Tyner.

Wolter, J. Reimer. **Melanoblasts of the normal human choroid.** A.M.A. Arch. Ophth. **53**:211-214, Feb., 1955.

Choroidal melanoblasts have been considered of little importance. The author believes them to be part of a complicated system establishing contact between the vessels and nerves. Thus they should be of considerable importance to retinal metabolism. (10 figures, 14 references)

G. S. Tyner.

2

GENERAL PATHOLOGY, BACTERIOLOGY, IMMUNOLOGY

Avakian, A. A., and Akopian, A. T. **Development and growth of trachoma virus and the nature of inclusion bodies.** Vestnik oftalmologii **33**:34-42, 1954.

Scrapings from the conjunctiva in 135 patients with trachoma in different stages, were made and inclusion bodies were found in 36 of them. Biopsies were done in 20 patients. Various staining methods were used but the most satisfactory was staining with methylene blue and diluted carbol-fuchsin. The phase microscope was used on unstained slides. Slides prepared by Fuelgen's method were checked for thymo-nucleic acid. The authors conclude that intracellular inclusions have characteristics of viruses. Elemental bodies have characteristics of the virus matter. Plastin is produced by the reaction of the cell plasma to the virus. The authors feel that differences in the elemental bodies are due to the location and the condition of the epithelial cell and do not represent different stages of development of the virus. Sylvan Brandon.

Babel, J. **Heterologous intracorneal transplant of cornea and sclera in an animal sensitized to heterologous proteins.** Ann. d'ocul. **188**:22-26, Jan., 1955.

When a heterologous corneal or scleral graft was transplanted interlamellarly into the cornea of a rabbit previously sensitized to serum or corneal proteins from the same species, a severe local anaphylactic reaction occurred, which did not take place when the sensitization was induced after the transplantation. (6 references) John C. Locke.

Bruna, F., Balducci, D., Boemi, G., and Felici, A. **Experimental demyelinating allergic encephalitis. Preliminary research in the use of a potentiated antiherpetic vaccine.** Boll. d'ocul. **34**:109-116, Feb., 1955.

Four different antigens obtained from mouse and chick embryo and emulsioned in Bayol and Arlacel did not produce a demyelinating allergic encephalitis in the inoculated guinea pigs. The author believes such a negative response is a sine qua non for experimental study in man of an antiherpes vaccine prepared by emulsion in Bayol and Arlacel of infected mouse brain. (18 references)

William C. Caccamise.

Cibis, P. A., Noell, W. K., and Eichel, B. **Ocular effects produced by high-intensity X-radiation.** A.M.A. Arch. Ophth. **53**:651-663, May, 1955.

Experimental animals were exposed to X-radiation in total doses ranging from 1700 to 35,000 r. The most significant change is the death of rod cells. The minimum lethal dose for the rods is 1700 to 2000 r. Cones have a higher lethal dose, 10,000 to 30,000 r. Cell changes occur in a few hours. (20 figures, 15 references)

G. S. Tyner.

D'Ermo, F. **A study of the permeability of the blood-aqueous barrier in so-called anaphylactic shock in the rabbit.** Boll. d'ocul. **34**:138-142, March, 1955.

Using the fluorescein method of Amsler and Huber for detecting the permeability of the blood-aqueous barrier, the author found that in sensitized rabbits which were in shock there was an almost im-

mediate appearance of fluorescein in the anterior chamber. The concentration in the aqueous rose rapidly to a maximum which was maintained until the death of the animal. The author previously demonstrated the presence of histamine in the aqueous humor of sensitized rabbits which were then given an intravenous injection of the antigen. The author believes that the pathogenetic mechanism of anaphylactic shock in the rabbit consists not only of an antigen-antibody reaction but also of a histamine component. (1 figure, 16 references) William C. Caccamise.

Ikeda, I., Komi, T., and Nakaji, H. **Nonspecific choroidal reaction and nonspecific sensitization.**

Nakaji, H. **Corneal changes of rabbits caused by shock.** Acta Soc. Ophth. Japan **59**:452-454, and 539-543, May and June, 1955.

In the first part, the authors report that choroidal lesions are brought about by electro-shock and the like. A foaming substance appears in the choroid within 20 seconds after shock and the tissue looks as if it were boiling. It disappears within one hour. An explosive hemorrhage which sometimes occurs after shock seems to be a sequel of the formation of this foaming substance. The lesion occurs, however, only after a repetition of shocks. The authors consider, therefore, that a sensitization by shocks is a basic condition of the manifestation of the choroidal lesions. (2 figures, 1 reference) In the second part, Nakaji states that a corneal opacity can result after a repetition of the shocks. (1 figure, 3 tables, 6 references)

Yukihiko Mitsui.

3

VEGETATIVE PHYSIOLOGY, BIOCHEMISTRY, PHARMACOLOGY, TOXICOLOGY

Cogan, D. G., and Kuwabara, T. **Lipogenesis by cells of cornea.** Arch. Path. **59**:453-456, April, 1955.

A method is described wherein local lipogenesis is produced by injecting corneal buttons with a fatty acid and placing them in a defatted serum bath at a specific pH. The conclusion is drawn that a true lipogenesis may be brought about in the presence of viable cells by oleic acid or sodium oleate and a certain serum factor. The importance of this finding, that corneal cells, fibrocytes, macrophages, and possibly other cells are capable of true lipogenesis, is stressed. (3 figures, 1 color plate, 8 references) Harry Horwich.

Dejean, C. Thibaud, and Paycha. **Determination of intraocular radioactive phosphorus.** Bull. et mém. Soc. franç. d'opht. **67**:187-199, 1954.

This is a preliminary report on the distribution of P32 inside the eyeball. The P32 used in this experiment was delivered from the atomic pile of Harwell in form of an aqueous solution of disodium phosphate of HLT = 14.3 days, emitter of a continuous Beta-irradiation of an average energy of 0.69 Mev. It was graded with the Geiger counter in vivo.

In a series of experiments on rabbits the content of P32 in the anterior chamber was established after an intravenous injection of P32 in the marginal vein of the auricle. The blood-aqueous barrier acted as a semipermeable membrane towards P32. The P32 content of the various layers of the eyeballs was established after enucleation and tabulated.

In the examination of patients, the routine exploration with the Geiger-counter gave information about the concentration of P32 in somewhat less than the anterior half of the eyeball. Nevertheless a distinct dyssymmetry in the up-take of P32 and an increase of this dyssymmetry in 24 and 48 hours was considered to be of importance. In spite of the established fact of the increased attachment of P32 to abnormal tissue, its application at present is of more scientific interest in the

evaluation of intraocular tumors, than of practical help. (20 references, 2 figures, 6 tables) Alice R. Deutsch.

De Simone, S. **Research on the respiration and anaerobic glycolysis of the rabbit cornea in cases of experimental neuroparalytic keratitis.** Boll. d'ocul. **34**:129-137, March, 1955.

The author reports the results of his investigation of glycolysis and respiration of the cornea in rabbits in which a neuroparalytic keratitis was experimentally produced. A significant reduction in both of these processes became apparent before any morphologic changes of the corneal tissue. The author emphasizes that the metabolic changes are local in nature and are induced by the sectioning of the trophic fibers from the ciliary ganglion to the cornea. Such a metabolic alteration may be a decisive factor in the pathogenesis of neuroparalytic keratitis. (4 tables, 10 references) William C. Caccamise.

De Vincentiis, Mario. **Electrophoretic studies of the hydrosoluble proteins of the lens in relation to experimental modifications of the intraocular fluids.** Arch. di ottal. **58**:403-409, Nov.-Dec., 1954.

The water-soluble lens proteins were studied after paracentesis, introduction of homologous plasma into the vitreous, diathermy coagulation of the sclera and iridectomy. Variations in the alpha and beta fractions were observed, consisting in an increase of the former and a decrease of the latter. (3 tables, 16 references)

John J. Stern.

Gemolotto, Guglielmo. **Electrophoretic examination of the protein concentration of the blood serum in some ocular affections. III a: Cataract.** Ann. di ottal. e clin. ocul. **81**:175-182, April, 1955.

Patients with cataract showed a decrease of albumin and an increase of gamma-globulin. These changes are probably due to age. (53 references)

John J. Stern.

Hayano, S. **A simple method of rhodopsin determination.** Acta Soc. Ophth. Japan **59**:596-598, June, 1955.

This is a method to measure, with the spectrophotometer, the absorption of light by rhodopsin of 500 mμ wave length. After an illumination at 200,000 lux for five minutes, rhodopsin loses the absorption capacity. Therefore, the reduction in absorption after the illumination gives the actual amount of rhodopsin. The determination should be made with a homogenate of the retina. The animals should be kept in the dark for five hours before the removal of the eye and the homogenate should be prepared from the retina in a dark room using ice-cold destilled water. A calculation curve and table of the absorption intensity to the amount of rhodopsin are also given. (2 figures, 3 tables, 1 reference) Yukihiko Mitsui.

Inamochi, J. **Fluorescein permeability of blood-aqueous barrier.** Acta Soc. Ophth. Japan **59**:284-293, 514-527, and 559-564, March, May, and June, 1955.

In this experiment in rabbits to observe the appearance of fluorescein into the anterior chamber by Amsler-Huber's method, eserine and pilocarpine accelerated the transit of fluorescein through the blood-aqueous barrier. Epinephrine injected subconjunctivally impeded it. Atropine and novocain had no effect. A removal of the ciliary ganglion accelerates the effect of pilocarpine but has no influence on the effect of other agents. A removal of the cervical ganglion accelerates the effect of epinephrine only. (25 figures, 20 tables, 146 references)

Yukihiko Mitsui.

Koide, Y. **Experimental studies on the regeneration of rhodopsin. I-III** Acta Soc.

Ophth. Japan **59**:605-617, June, 1955.

An alcohol dehydrogenase in the liver can bring about the reversible change between vitamin A and retinene. A homogenate of the retina contains a ferment which oxidizes vitamin A. The optimum pH for this ferment is 8.1. The extract of choroid accelerates the action of this ferment, although the former by itself has no fermentative action. Adenosine triphosphoric acid, magnesium ion, glutathione and succinate have the same effect. (5 figures, 8 tables, 25 references)

Yukihiko Mitsui.

Kozlowski, Bogumil. **Pituitary and the eye.** Klinika Oczna **24**:299-309, 1954.

The author provides a short summary of the data on the physiologic function of the pituitary gland and the relation of the pituitary to the eye and the visual paths. Experimental and clinical information indicate that the relationship between these two organs is sometimes very close. However, the effect of the pituitary on the vegetative nervous system and the other endocrine glands make definite conclusion as to the role of the pituitary very difficult. Heredity as a predisposing factor makes it even more difficult to determine the exact connection between the eye and the pituitary. (9 references)

Sylvan Brandon.

Odahara, H. **Mechanism of cataract development in alloxan diabetic animals.** Acta Soc. Ophth. Japan **59**:576-579, June, 1955.

Alloxan was given to rats intravenously at the rate of 7 mg. per 100 gm. body weight. Rats four to six months old and of about 100 gm. body weight were used. In the series in which a food with five percent caseine was given, the development of a cataract was observed 28 to 51 days after the injection of alloxan. In another series in which a food with 22 percent casein was given, cataract developed 12 to 15 days after the injection. The development of cataract was considerably accelerated by an increased administration of protein.

Uyama and his collaborators demonstrated that the development of senile cataract had a relation to an abnormal metabolism of tryptophane. Odahara considers the present experiment to indicate that cataract development has a relation to the metabolism of amino acid, and therefore the result corroborates the theory of Uyama. (3 tables, 16 references)

Yukihiko Mitsui.

Ozaki, S. **Energy development in the lens and its role in the regulation of osmotic pressure.** Acta Soc. Ophth. Japan **59**:621-632, June, 1955.

A dehydration of the crystalline lens is brought about in vitro in isotonic solution when such a ferment-interrupter as KCN and mono-iod-acetic acid is added. The dehydration is, however, prevented when adenosine triphosphoric acid is added. After some additional experiments Ozaki concludes that an oxidation of glucose and similar substances gives energy to the lens to regulate the osmotic pressure of the tissue. (10 figures, 21 tables, 6 references)

Yukihiko Mitsui.

Rouher, F., and Tronche, P. **Experimental galactose-cataract in the rat.** Bull. et mém. Soc. franç. d'opht. **67**:37-41, 1954.

Experimental galactose cataract in albino rats was comparatively easily produced with the technique described. The young rats were separated from the litter after eight days and the amount of galactose in their feedings was increased 10 percent each week until the galactose content amounted to 50 percent. No animals were lost. The first signs of lens opacities appeared 14 days after the start of the galactose feeding. The development of the cataract was symmetrical in both eyes and followed a typical pattern, beginning

in the cortex. The lens nucleus began to get cloudy after 45 days. After 90 days the cataracts were total and intumescent with obliteration of the anterior chamber. Injections of fish lens proteins were tried to combat the toxic effect of galactose, but they proved to be unsuccessful as was previous medication with vitamins C and B, or salts of potassium. (34 references) Alice R. Deutsch.

Venturi, G., and Capalbi, S. **The effect of tetracycline chlorhydrate on experimental ocular infections with herpes and vaccine virus.** Arch. di ottal. **58**:395-401, Nov.-Dec., 1954.

Tetracycline had no curative effect in herpetic or vaccine infection of rabbits. (24 references) John J. Stern.

4

PHYSIOLOGIC OPTICS, REFRACTION, COLOR VISION

Fisher, E. J. **Clinical observations on the fitting of micro-lenses.** Am. J. Optometry **32**:289-294, June, 1955.

Microlenses have some advantages in fitting, but the wearing time is short in many cases. Vision and comfort are greater when a wetting agent is used.

Paul W. Miles.

Graham, R. **Contact lens resources.** Am. J. Optometry **32**:319-326, June, 1955.

This is an excellent discussion of the various types of contact lenses available. The contact surface may be toric as well as spherical. There are various methods of "ventilation" for tear flow. Corneal lenses may be lenticular when the correction is high. Tri-curve lenses are in use for keratoconus. Contact lenses may be tinted for photophobia, to change the iris color, or to create an artificial pupil.

Paul W. Miles.

Jayle, E., Camo, R., Boyer, R., and Ansoldi, I. **Principles of and results in the cinematographic evaluation of night vision.** Bull. et mém. Soc. franç. d'opht. **67**:508-524, 1954.

In the first part of this report the instrument in use and the techniques are described. In the second the evaluation of the responses of 108 persons between 17 and 22 years of age without eye disease are evaluated and an analytical study of the adaptation-threshholds and curves is presented. In the third part the correlation of the different thresholds and their significance is discussed.

The value of cinamatographic exploration of night vision consists in a more real appraisal of the successive phases in dark adaptation and in the attempt to give additional orientation to the standard tests; because of that, a better judgement of the individual capacities and the working abilities in reduced illumination should be possible. (7 tables)

Alice R. Deutsch.

Junès, E. **Some remarks concerning the horopters.** Ann. d'ocul. **188**:254-279, March, 1955.

The author defines two kinds of horopters, one objective, the other subjective. The former (fixation horopter) is in direct relationship with the right and left ocular retinas. The latter (projection horopter) is in direct connection with the cyclopean retina. The characteristics of each are described in detail. (9 figures, 1 table, 9 references) John C. Locke.

Kruger, A. J., Ornee, P. B., and v. d. Eijk, J. **Blackboards or colored boards in school classrooms?** Ophthalmologica **129**:128-136, Feb., 1955.

The legibility of white chalk writing at illuminations between 2.5 and 6.5 foot candles was not significantly influenced by the color (hue) variations of the background. (1 figure, 2 tables)

Peter C. Kronfeld.

Manas, L., **The inconstancy of the ACA ratio.** Am. J. Optometry **32**:304-315, June, 1955.

More evidence is presented of the variation in repeatability of the ratio between accommodation and convergence. In the same individual the accommodation-convergence ratio varies daily as much as 1.8 units. There are variations with age and presbyopia. This might be expected because of the slowness of accommodation and the rapidity of convergence. The ratio can be modified by visual training. The ratio of myopes is higher than that of hypermetropes. Paul W. Miles.

Mandels, S. J. **Spasm of accommodation.** Vestnik Oftalmologii **33**:38-39, 1954.

Spasm of accommodation in a man, 20 years of age, brought about pseudomyopia. After a few days of treatment with atropine moderate hyperopia was found. The visual acuity returned to normal after the treatment.

Sylvan Brandon.

Marquez, Manuel. **More about true and false torsion.** Ophthalmologica **129**:137-140, Feb., 1955.

Pascal, Joseph. **Addendum to the foregoing article.** Ophthalmologica **129**:206, March, 1955.

For the determination of the position of the originally vertical meridian of the globe during false torsion, Marquez recommends actual observations and measurements on suitably marked rubber balls. Such observations have convinced Marquez that, for example, during rotation of the right eye around an axis located in Listing's plane and making an angle of 45° with the horizontal plane the upper end of the originally vertical corneal meridian inclines inward while the upper end of the originally vertical retinal meridian inclines outward.

Pascal who translated Marquez's article from the Spanish into English now makes this comment: "Experiments with balls as Marquez describes in this article, as well as similar experiments which I have made, seemed to show that in false torsion the corneal and retinal meridians do rotate in opposite directions. However, some new experiments more recently performed, seem to show the contrary, namely that the corneal and retinal meridians rotate in the same direction, but possibly not to the same extent. I have not yet concluded these experiments. But I hope they will help to unravel this puzzle in pseudotorsion." The reader is again referred to the work of Quereau who on his large-scale model of the human eyeball finds that during false torsion corresponding corneal and retinal meridians are tilted in the same direction with reference to the objective vertical meridian (cfr. Arch. Ophth. 51:783, 1954). (8 references) Peter C. Kronfeld.

Siliato, Francesco. **The importance and significance of the optical factors which influence the process of formation and resolution of images at different distances. (Experimental research)** Ann. di ottal. e clin. ocul. **81**:207-217, May, 1955.

An analysis of the effects of a lens of + or − 0.75D. on visual acuity at different distances allows the conclusion that a negative accommodation cannot be demonstrated and that the eye possesses a certain depth of focus. (1 table, 15 references) John J. Stern.

Smith, W. **Report of visual screening tests in a group of ten reading problem cases.** Am. J. Optometry **32**:295-303, June, 1955.

Stereoscopic instruments are inadequate for screening school children.

Paul W. Miles.

5

DIAGNOSIS AND THERAPY

Boles-Carenini, B., and Cima, V. **The results of beta-therapy in some diseases of**

the lids, conjunctiva, and cornea. Boll. d'ocul. **34**:143-156, March, 1955.

The authors discuss the indications for beta-radiation therapy together with the characteristics of various types of beta applicators. After reviewing the literature the authors report the results which they personally obtained in 68 cases of palpebral, conjunctival or corneal disease. This form of therapy is particularly helpful in those external conditions which are characterized by a predominence of neovascularization. (5 tables, 24 references)

William C. Caccamise.

Carswell, W. E. **Presidential address.** Tr. Ophth. Soc. New Zealand pp. 7-12, 1954.

Several interesting vascular affections are recorded: a group of cases of visual hallucination, a case of cranial arteritis, a case of papilledema of obscure origin, and one of hemangioma of the lower orbit. An outline of the successful treatment of hemangioma with injections of urethane and quinine and later with surgical excision is given. (3 figures)

Robert A .Moses.

Cosentino, D. **On the use of cortisone in ophthalmology.** Boll. d'ocul. **34**:171-180, March, 1955.

The author analyses the results which he obtained in the local and subconjunctival use of cortisone in 425 patients with various diseases. In general these results are similar to those which have been extensively reported by American ophthalmologists. (1 table, 30 references)

William C. Caccamise.

Dekking. **An instrument to measure the cloudiness of the cornea and lens.** Bull. et mém. Soc. franç d'ophh. **67**:312-317, 1954.

The instrument described is the fourth of this kind constructed by the author. It consists of the illuminating system which gives a circular field of fixed and homogenous luminosity (light-bulb of 6 volts, 3 amperes). The illumination device and the visual line of the microscope form a fixed angle of 30°. The microscope provides a magnification of 3.2, contains two Porro prisms to make the image erect, a field lens on which the image is formed and an ocular with a magnifying power of 4. The photometric system has the same light source, has a collimeter set and one disc of rotating and another of fixed polaroids. This apparatus is said to be easy to use.

Alice R. Deutsch.

Doden, Wilhelm. **Lanthasol-Aerosol inhalations in chronic ocular infections.** Klin. Monatsbl. f. Augenh. **126**:475-478, 1955.

This inhalation mixture contains some rare elements, especially cerium. Some authors have postulated that it improves chronic inflammation. The author tried it on 38 patients with ocular infections without any benefit. (21 references)

Frederick C. Blodi.

Goldmann, M. H. **A new aplanation-tonometer.** Bull. et mém. Soc. franç. d'opht. **67**:474-478, 1954.

Considerable changes had to be made for the adjustment of this new type, as it is applied to the patient sitting at the slit-lamp. With this instrument the flattening of the cornea can be read directly by adjustment of the slitlamp. The normal tension is 15.5 mm. Hg. A tension of 21 mm. Hg is suspicious, 23 is probably too high and 24.5 mm. Hg is pathologic. The tonometer is manufactured by Haag-Streit. (2 figures)

Alice R. Deutsch.

Hoette, H. **A new iris repositor.** Klin. Monatsbl. f. Augenh. **126**:481-482, 1955.

This is a regular spatula which contains a wire within its distal part. This wire can be released by a lever on the shaft. It then appears like a thorn for a length of 2 mm.

at the lower end of the spatula. This thorn enables the surgeon to catch the iris and push it into its correct position. When the spatula is withdrawn the lever is released and the wire disappears. It should only be used in aphakic eyes. (2 figures)

Frederick C. Blodi.

Joly, P., and Lavat, J. **Retinography in identical twins.** Bull et mém. Soc. franç. d'opht. **67**:466-473, 1954.

The diagnosis "identical twins" depends chiefly on the external resemblance. Sometimes even dizygotes look very much alike. Therefore the diagnosis "monozygotism" needs additional support. The iris marking, so variable in the white race, is similar in monozygotic twins but might be similar also in fraternal twins. The study and comparison of the fundi in twins seemed to be an interesting endeavour. Therefore the retinographic pictures of 20 sets of identical twins were systematically examined with special attention to the fundus in general, the appearance of the dics and the maculae. A considerable resemblance was mostly present. If twins do not have an identical fundus picture they are not necessarily dizygotes. Identical fundus pictures, however, establishes them as monozygotes. (3 figures) Alice R. Deutsch.

Luescher, Albert Joseph. **Objective methods for the determination of visual acuity.** Ophthalmologica **129**:116-128, Feb., 1955.

This study is essentially a comparison of Goldmann's and Guenther's method for the objective estimation of the visual acuity. For a brief description of the former method the reader is referred to the study by Pfister (cfr. Am. J. Ophth. 30:1064, 1947). Guenther's method utilizes checkerboard patterns moved horizontally at controlled speed and viewed by the examinee through a tube. Movement of the pattern and, particularly, sudden stops or reversals of direction elicit an optokinetic nystagmus which becomes less pronounced with decreasing pattern size or increasing observation distance. This optokinetic nystagmus has a fairly definite lower threshold. This threshold value is related to the visual acuity.

Systematic comparison of the two methods reveals superiority, that is greater accuracy, of Goldmann's method. In a certain number of cases both methods fail in that a poor optokinetic response is associated with excellent subjective acuity and no demonstrable abnormaltiy of the eye under examination. (4 figures, 10 references) Peter C. Kronfeld.

Mielnik, Irena. **Small improvement in the technique of tissue treatment.** Klinika Oczna **24**:297-298, 1954.

Preserved placental tissue is crushed and suspended in a mixture of saline solution and 1/5000 penicillin. This pulpy mass is injected under the conjunctiva with the help of a syringe which has controlled movement of the plunger. This method of application of tissue therapy does not require any surgical procedure. Sutures are not used and it may be done in ambulatory patients. (1 figure)

Sylvan Brandon.

Mielnik, I., and Przyborowska, H. **Diagnostic value of Kestenbaum's sign.** Klinika Oczna **24**:293-295, 1954.

The authors investgiated the value of Kestenbaum's sign in optic atrophy. They examined 27 normal eyes and 59 eyes with optic atrophy, among them 15 glaucomatous eyes. They feel that Kestenbaum's sign is of relative value and that the total number of blood vessels, big and small, is more significant than just the number of small blood vessels leaving the disc. (2 figures) Sylvan Brandon.

Rougier, J. **The correction of unilateral aphakia by contact lenses and by Ridley**

lenticles. A comparative study. Bull. et. mém. Soc. franç. d'opht. **67**:391-406, 1954.

Eighty-nine patients with monocular aphakia were examined, 60 of whom had contact lenses. The operations were performed by various ophthalmologists near Lyon, France. The Ridley operation was performed in 29 patients by L. Paufique. Binocular vision was tested in 36 wearers of contact lenses and 18 wearers of Ridley lenses. The re-establishment of binocular vision was far better after the Ridley operation. Nevertheless the indications for this operation are very restricted because perfect anatomical conditions are indispensible, especially an intact posterior capsule. Contact lenses should be carefully fitted as soon as possible after the cataract operation, exotropias should be surgically corrected with special care to avoid conjunctival scarring as much as possible. Conjunctival scars are irritating to the wearer of contact lenses. A more general use of contact lenses in monocular aphakia is definitely justified and should be encouraged. (9 references)

Alice R. Deutsch.

Salgado-Gomez, E. **Scleral resections.** Bull. et mém. Soc. franç. d'opht. **67**:127-145, 1954.

The indications for scleral resections in retinal detachments and in progressive myopia are discussed. The author uses lamellar resections and distinguishes between total and partial resection. His technique is described in detail. In total scleral resection he removes a strip of sclera, 3 to 4 mm. wide, through 360 degrees of the scleral circumference and through two-thirds of the scleral thickness. He recommends subconjunctival air injection for easy dissection of the conjunctiva, plastic suture material for the folding of the sclera (because of early resorption), a few localized diathermy punctures for release of the subretinal fluid, and puncture of the anterior chamber with a knife needle before the closure of the scleral wound. In partial scleral resection the excised scleral band measured 90 to 180 degrees of the scleral circumferenec. Partial scleral resection improves the prognosis in those cases of detachment in which the retina did not flatten out during rest in bed or in which diathermy coagulation had been unsuccessful. Total scleral resection may prove helpful in long-standing and extensive detachment which was previously believed to be incurable. Five pertinent case histories are reviewed.

No surgical complications after scleral resections in myopia are mentioned. This procedure brings about shortening of the sagittal diameter of the eyeball, protection of the sclera and the other membranes against further distention, prophylaxis for scleral separation, and reduction of the myopia. Alice R. Deutsch.

Siegert, P. **Diagnostic evaluation of serologic tests in ocular diseases.** Klin. Monatsbl. f. Augenh. **126**:257-272 and 385-400, 1955.

This is a review-article on a few important serologic tests. The tests for syphilis are quite specific and false positive results occur only in a few well-known conditions. However, a positive test does not necessarily mean that the present eye condition is really a syphilitic one.

The sero-diagnostic tests for gonorrhea are also quite reliable. They may, on the other hand, give a positive result if other serologic tests (for instance lues, tuberculosis) become positive.

The serologic tests for tuberculosis are thought to be unreliable, but in a series of patients with endogenous uveitis the test was positive in 16.6 percent of the patients as compared with 7.8 percent in control cases. The positive reactions were most frequent in patients between one and twenty years of age and again between forty and seventy.

The serologic tests for toxoplasmosis have to be carefully evaluated. The diagnosis of a toxoplasmic chorioretinitis in adults is usually indirect and can hardly be proven. The compliment fixation test is here extremely sensitive, but often unspecific. (4 figures, 16 tables, 47 references)

Frederick C. Blodi.

Thies, O. **Experiences from a surgical practice.** Klin. Monatsbl. f. Augenh. **126**: 483-489, 1955.

The author uses conjunctival sutures only occasionally, usually none at all. The incision is made with a knife and should be very fast. Among the postoperative complications a small iris prolapse is often more troublesome than a large one.

For patients with glaucoma the author performs a trephine operation several millimeters away from the limbus. Through this opening a cyclodialysis and complete iridectomy are done (Schieck). The squint operations are done on ambulatory patients. The guarded tenotomy is preferred. (8 references) Frederick C. Blodi.

Velicky, Jiri. **Treatment of ocular tuberculosis with isoniazid.** Ophthalmologica **129**:111-115, Feb., 1955.

The ophthalmologist of a tuberculosis sanitarium located in a mountainous part of Czechoslovakia (elevation about 3000 ft.) attempts evaluation of the results of isoniazid treatment (5 mg. per Kg. of body weight per day for 50 to 70 days) in 30 cases of granulomatous, solitary or disseminated choroiditis, 14 cases of periphlebitis and 16 cases of anterior uveitis or sclerokeratitis. Definite improvement, seemingly attributable to the chemotherapy, occurred in a very considerable percentage of the cases of choroiditis but not in any of the other groups. In cases of periphlebitis with severe hemorrhages the author has seen a number of acute exacerbations following streptomycin or isoniazid therapy and, therefore, prefers "climato-hygienic" treatment, that is complete rest with dietetic supportive measures. (1 table, 2 references)

Peter C. Kronfeld.

Yamada, K. **Relation between retinal blood pressure and cerebrospinal fluid pressure. II.** Acta Soc. Ophth. Japan **59**: 579-587, June, 1955.

The retinal blood pressure, spinal fluid pressure and Ayara's quotient vary proportionately. However, in case of higher spinal pressure than 300 mm. H_2O, the quotient is apt to decrease with an increase in the spinal fluid and blood pressure. Such a paradoxical phenomenon is generally seen in cases of hypertension of Keith-Wagener types III and IV. (3 figures, 4 tables, 17 references)

Yukihiko Mitsui.

6

OCULAR MOTILITY

Baranowska, Teresa. **Orthoptic and surgical treatment of latent squint.** Klinika Oczna **24**:242-253, 1954.

Orthoptic training was used in 24 cases of exophoria where symptoms of fatigue were present. An amblyoscope was used for exercises at near and the telestereoscope for distance. In five cases treatment resulted in a permanent cure, four patients did not respond to treatment and in two cases results are unknown. In all cases where improvement was registered, objective examination revealed a decrease of exophoria and increase of fusion amplitude. Even in cases of recurrence of subjective symptoms the degree of exophoria and fusion were better than initially. Surgery was used in large exophorias: recession of the lateral rectus muscles proved to be rather disappointing. The author feels that tucking of the internal rectus muscles should give better results. (8 figures, 9 references)

Sylvan Brandon.

Hartmann, E., and Saraux, H. **Surgery of convergent strabismus. Relationship between operative performance and correction obtained.** Ann. d'ocul. **188**:301-317, April, 1955.

Operative results in 89 cases of convergent strabismus are studied from the point of view of the dioptric correction obtained per millimeter of recession or advancement-resection. There was an extreme variability of results of recession (from 0 to 7.5 diopters per millimeter of recession). Advancement-resection gave more consistent results (about three prism diopters per millimeter in most cases). Greatest correction per millimeter was observed in resections of four millimeters. When resection and recession were done at the same time, the effect obtained from either of these operations when performed separately, appeared to be increased by one-third. The presence of amblyopia or anomalous correspondence seemed to have no effect. Correction per millimeter was greatest when the initial deviation was greatest and in patients between the ages of six and ten years. (11 tables, 5 references)

John C. Locke.

Hugonnier, R., Etienne, R., and Douthwaite, C. M. **Postoperative diplopia in strabismus.** Ann. d'ocul. **188**:173-181, Feb., 1955.

The risk of postoperative diplopia following strabismus surgery is greatest in patients over the age of 15 years, and is negligible under the age of 8 years. It is most likely to occur in patients with anomalous retinal correspondence or large-angle deviation, or who have had surgical overcorrection. Ill-advised preoperative orthoptic procedures result in diplopia. Orthoptic treatment should not be attempted in patients over the age of 8 years when there is no fusion at the objective angle of squint, or when there is anomalous retinal correspondence. The risk of postoperative diplopia can be estimated by having the patient fixate a light through correcting prisms. If double vision does not occur then, it is not likely to occur postoperatively.

John C. Locke.

Madronszkiewicz, Marian. **Measurements of muscular power in squinting and normal eye.** Klinika Oczna 24:255-266, 1954.

Direct measurements of the power of eye muscles were made by the author with the help of a specially adapted Miller's ophthalmodynamometer. Measurements were taken during eye surgery, mostly for squint. A thread was put through the tendon of the muscle to be examined and attached to a special hook on the ophthalmodynamometer, which was specially calibrated for measurement of weight ranging from 2 to 81 grams, and 54 measurements were taken. In normal eyes the strength of the internal rectus muscle was about equal to the strength of the lateral rectus. A normal internal rectus muscle could lift 60 gm. In convergent squint the strength of the internal rectus reached 75 gm. but the lateral rectus muscle was considerably weaker, the difference reaching 35 gm. In divergent squint the lateral rectus muscle was stronger than the internal rectus. In paralysis the strength of the affected muscle was very small or totally absent. Normally the strength of an eye muscle is many times stronger than is necessary to lift the weight of the eye. (1 figure, 2 tables, 6 references) Sylvan Brandon.

7

CONJUNCTIVA, CORNEA, SCLERA

Agarwal, L. P., and Saxena, R. P. **Conjunctival smear cytology in trachoma.** Ophthalmologica **129**:93-98, Feb., 1955.

The subject of this study was the cytology of trachoma as represented in tissue

scrapings obtained from the upper fornix by means of a sharp curette. These scrapings contained epithelial as well as follicular material. In addition to the well established features of trachoma (inclusion bodies, germinal cells and Leber cells) the author found characteristic epithelial changes, that is multinucleated cells and complete disintegration with extrusion of the nucleus. (6 figures, 7 references)

Peter C. Kronfeld.

Bonhoure, C. **Lamellar keratoplasty using lyophilised preserved graft.** Ann. d'ocul. **188**:49-54, Jan., 1955.

Using lyophilised cornea as donor material, favorable results were obtained in the treatment of a large vascularised pterygium by lamellar keratoplasty. (2 figures) John C. Locke.

Chinaglia, V. **Congenital central corneal opacity. (Clinical and histologic contribution)** Ann. di ottal. e clin. ocul. **81**:139-168, April, 1955.

An infant, four months of age, is described who had a central, disc-shaped, vascularized opacity in each cornea separated from the limbus by a zone of normal cornea. The opaque disc was adherent to the pupillary border. No hereditary factors could be found, nor had the mother been ill during pregnancy. There were no other malformations. A marked hypertension had produced a secondary hydrophthalmos. A corneal transplantation was performed which revealed a complete aphakia. The opaque portion removed from the eye showed fibrous connective tissue in the anterior half of the cornea. Bowman's membrane was absent. Biomicroscopic and histologic findings excluded an inflammatory factor and suggested an anomaly of the mesodermal development. (13 figures, 109 references)

John J. Stern.

Ciring, J. E. **Intraocular nonmagnetic foreign bodies and their removal.** Vestnik Oftalmologii **33**:35-36, 1954.

In five years 32 patients with a nonmagnetic intraocular foreign body were seen. In nine of them it was in the anterior chamber of the iris, in one in the posterior chamber, in four in the lens and in 18 in the posterior part of the eye. Keratome incision was used to remove the foreign body from the iris, and linear incision when it was in the chamber angle. A suture placed on the corneal lip of the incision permitted better inspection and facilitated the removal of the foreign body. Approach through the sclera was with the help of a flap incision. When the foreign body could not be seen it could be found in the globule of the organized exudate from the vitreous after its removal. In 23 eyes inflammation subsided and the vision improved. In six eyes the inflammatory symptoms continued and enucleation became necessary. Sylvan Brandon.

Hervouet, F., Lenoir, A., and Chevannes. **Noteworthy details of pterygia.** Bull. et mém. Soc. franç. d'opht. **67**:444-460, 1954.

This superior pathologic study is based on a systematic examination of serial slides with special emphasis on the difference in structure of the central part and the margins of a pterygium. Marked by exactness and thoroughness this study contributes to the understanding of the pathogenesis of pterygia. (27 figures)

Alice R. Deutsch.

Legrand, J. **Acrylic corneal prosthesis.** Bull. et mém Soc. franç. d'opht. **67**:407-414, 1954.

The inclusion of an acrylic prosthesis into a cornea which could not be kept clear by a corneal transplant seems to be an ideal solution. The present report is the continuation of a preliminary study, published in December, 1953. The acrylic prosthesis used has a diameter of 7 mm.

The central portion has a thickness of 1.5 mm.; the margins are as thin as possible and should fit a furrow in the corneal tissue of the host after a central perforating disc of the central cornea has been removed by trephine. The operation was tried five times in blind eyes. In spite of the fact that the discs were not retained, the author believes that the operation could be successful as soon as the surgical technique is improved and reactive inflammation controlled. (7 figures)

Alice R. Deutsch.

Moretti, E. **The etiology of keratoconus.** Boll. d'ocul. **34**:181-184, March, 1955.

The author mentions various factors (ocular hydrostatic pressure, congenital dystrophy, influence of the sympathetic and hormonal systems) which have been described as possible causes of keratoconus. Basing his opinions primarily on approximately 70 cases of keratoconus which he has examined, the author suggests that this pathologic condition is not congenital in nature but appears during puberty and is due to an imbalance in the autonomic nervous system with a resultant disturbance in the nutrition of the corneal tissue. William C. Caccamise.

Orlowski, Witold J. **Problem of pterygium.** Klinika Oczna **24**:310-314, 1954.

Pterygium has been known and has been operated on for centuries. Hundreds of methods were suggested for its removal but recurrences are seen and reported in from two to 16 percent of cases. The author describes five methods suggested by Polish authors. He feels that as long as the real cause of the growth of pterygium is not found, the treatment will be only empirical. (39 references)

Sylvan Brandon.

Sommer, Gerd. **A modification of Guenther's protection of a corneal graft.** Klin. Monatsbl. f. Augenh. **126**:426-430, 1955.

Guenther advised in 1951 to cover the corneal graft, which is not sutured, with another total cornea sutured to the host limbus.

The author uses fixed cornea (1 percent formaline in physiologic saline solution) which is washed before use. This hardens the cornea somewhat and makes it easier to handle. In addition a trephine opening (2 mm. smaller than the original graft) is cut into the center of the protecting cornea. This makes a window through which the graft can be closely watched. (2 figures, 11 references)

Frederick C. Blodi.

Voinova, T. J., Zacepina, N. D., and Michina, M. J. **Treatment of trachoma with sintomycin.** Vestnik Oftalmologii **33**: 13-17, 1954.

The authors treated 136 patients in all three stages of active trachoma. Sintomycin was used internally and locally with good results. Some toxic effects were noted. Sylvan Brandon.

Wilczek, Marian. **Recurrence of trachoma.** Klinika Oczna **24**:275-278, 1954.

Recurrence of acute trachoma was observed by the author in about 5 percent of patients treated for this disease. In some cases recurrence appeared before the end of the original treatment, in others it appeared after the treatment was completed, even a few months later. That the recurrence of inflammation was really trachoma was proved by all laboratory tests available. Most of the time both eyes were involved but unilateral infection was seen also. The reason for the reappearance could not be determined. The type of treatment of the original condition had no bearing on the appearance of recurrence. Investigation of 37 cases of recurrence did not reveal the pathogenesis. The recurrence frequently appeared soon after the expression of trachoma follicles. The treatment of recurrences usually lasted as

long as the usual treatment of acute trachoma. As a rule the author did not use the drug which had been used previously. Penicillin ointment seemed to be the most effective agent in treatment of recurrences. Sylvan Brandon.

8

UVEA, SYMPATHETIC DISEASE, AQUEOUS

Macdonald, G. **Lens-induced uveitis and glaucoma.** Tr. Ophth. Soc. New Zealand pp. 53-60, 1954.

Five cases of uveitis and glaucoma which the author feels were induced by sensitivity to lens protein are presented and discussed. Only one of the four patients tested had skin sensitivity to lens protein. The literature is reviewed. (1 table, 14 references) Robert A. Moses.

Redslob, E. **The nature and prognosis of melanocarcinoma of the choroid.** Ann. d'ocul. **188**:201-218, March, 1955.

The pertinent literature is reviewed. (59 references) John C. Locke.

Schumann, Eberhard. **Contact irradiation of iris cysts.** Klin. Monatsbl. f. Augenh. **126**:433-446, 1955.

The author uses a Chaoul tube number VI which is put on the closed lids so that the surface of the lids lies in the plane of the emergent rays. Skin-target distance was 5 cm. kV and 6 mA. 100 r was given daily for ten days. Six patients were treated. In three subjects spontaneous iris cysts responded favorably. The other three cysts were postoperative or traumatic. One eye had to be enucleated, one eye could not be followed and one cyst remained unchanged. (4 figures, 53 references) Frederick C. Blodi.

Steiger, R. M., Boehringer, R. M., and Wonderly, C. **Quantitative and electrophoretic examinations of the human secondary aqueous.** Klin. Monatsbl. f. Augenh. **126**:490-492, 1955.

Normal human (amblyoptic) eyes were used. The spectrophotometric analysis showed that the protein content of the secondary aqueous varies considerably from patient to patient. It is not related to the age of the patient. The total aqueous volume was not determined and it is possible changes in the amount of aqueous withdrawn influence the results.

For the electrophoretic examinations the aqueous of three patients had to be pooled. The β-globuline decreases in the secondary aqueous. (2 figures, 1 table, 26 references) Frederick C. Blodi.

9

GLAUCOMA AND OCULAR TENSION

Fritz, A. **Determination of the nerve pathways in capillary hypertension of the glaucomatous eye.** Bull. et mém. Soc. franç. d'opht. **67**:525-530, 1954.

The blood pressure in the capillaries of glaucomatous eyes shows some abnormalities in the early phase of this disease. The capillary blood pressure is unusually high as compared with the arterial blood pressure and for a short time may be as high as the average arterial pressure. This anomaly does not depend on an insufficiency of the precapillaries but is caused by active manifestations of the orthosympathetic system.

It was the purpose of this paper to show that blocking of the cervical sympathetic with procaine reduces the capillary hypertension of the eye in glaucoma. Paralyzing the ciliary ganglion with procaine also lowered the capillary pressure and blocked spontaneous rises as well as the increase which normally results from electric stimulation of the cervical sympathetic ganglia. (5 figures, 12 references) Alice R. Deutsch.

Harms, H. **Indications for lens extrac-**

tion in glaucoma. Klin. Monatsbl. f. Augenh. **126**:410-421, 1955.

Two specific indications are discussed. One is the socalled optical indication. In patients with chronic glaucoma and beginning lens opacities severe miosis may cut down vision so much that a lens extraction becomes necessary. Such an operation is preferred to a fistulating operation which may only accelerate the lens opacities.

The second indication is malignant glaucoma. In these cases the anterior chamber is shallow or absent and a large lens may be the cause of the trouble. Twelve such extractions are reported. The author uses a conjunctival flap, ab externo incision, appositional sutures and a total iridectomy. In patients with only one eye a general anesthesia is to be preferred. (1 table, 14 references)

Frederick C. Blodi.

Jarry, C., Jarlot, and Lhuillier. **Statistical study and discussion of late results in antiglaucomatous surgery.** Bull. et mém. Soc. franç. d'opht. **67**:479-483, 1954.

In this study 438 patients with chronic simple glaucoma were used. They were seen in the eye service at the hospital des Quinze-Vingts and were under observation at least two years. Some were under treatment as long as 25 years. The stage of the disease, the type of operation, the preservation of visual fields and visual acuity and the stabilization of tension were evaluated individually. In spite of the fact that early surgery seemed to be more successful, surgery should be undertaken only after medical control has failed. (2 figures) Alice R. Deutsch.

Kobzeva, V. J. **Glaucoma clinics.** Vestnik Oftalmologii **33**:18-22, 1954.

Glaucoma is considered to be a general disease of corticovisceral origin. Glaucoma clinics permit treatment of patients as a whole and not only the eyes. General examination followed by appropriate general treatment, including the change of conditions of work and life, are of definite help to glaucoma patients. Visiting nurses are of help, but their role is limited. The visiting doctor can accomplish much more by studying the conditions of work and home life of the patient, and helping the patient to remove all the noxious influences. Sylvan Brandon.

Koenig, H. **The use of tonographic tables.** Klin. Monatsbl. f. Augenh. **126**: 401-409, 1955.

The principles of tonography are explained. The author has put together (using the data of Friedenwald, Grant, Ballintine, and others) three tables, one each for the 5.5, the 7.5 and the 10 gm. weight. In each table the value C (coefficient for facility of aqueous outflow) and its reciprocal value R (impedence to outflow) can be easily found when the initial and final tonometric readings are known. It is interesting to note that the author uses a Schiøtz tonometer for tonography. (3 tables, 14 references)

Frederick C. Blodi.

Madroskiewicz, Marian. **Cycloelectrolysis and cyclodiathermy.** Klinika Oczna **24**:279-282, 1954.

The technique of cycloelectrolysis and cyclodiathermy are compared and three cases of absolute glaucoma in which cycloelectrolysis was used are described. In one case intraocular pressure remained normal after the operation, in a second case it gradually rose again, and in a third it was reduced. Cycloelectrolysis is more painful than cyclodiathermy, the procedure is more time consuming and the result is less certain. (1 figure, 1 reference)

Sylvan Brando.

Malbrán, J. L., San Martín, F. J., Rillo Cabanne, G., and Paunessa, J. **Effect**

of Diamox administration on intraocular pressure. Arch. oftal. Buenos Aires **29**: 576-583, Nov., 1954.

After some introductory remarks on the enzymatic reactions which result in the kidney in an active reabsorption of sodium, and a brief survey of Friedenwald and Kinsey's theory on the secretory activity of the ciliary body and of Becker and Grant's views on the influence of carbonic anhydrase inhibition upon the physiology of intraocular fluids, the authors report the results obtained with acetazoleamide (Diamox) in the treatment of 29 patients with abnormally elevated intraocular pressure.

The drug was given orally in 28 cases, and intravenously in one, in daily doses of 500 mg. More often than not, miotics were employed in addition to acetazoleamide. In most cases of primary glaucoma a definite reduction of tension occurred, and also in two cases of hypertensive uveitis, in two of glaucoma secondary to aphakia, and in one of infantile glaucoma. On the other hand, in one case of simple glaucoma, in one of chronic, closed-angle, iris-block type glaucoma and in one of essential atrophy of the iris there was practically no response. In several normal individuals who were used as a control, the drug was unable to alter significantly the intraocular pressure. Amsler and Huber's fluorescein test failed to detect any change in the permeability of the blood-aqueous barrier. (6 figures, 1 table, 11 references) A. Urrets-Zavalia, Jr.

Unger, Lothar. **Secondary glaucoma after retained intraocular foreign body.** Klin. Monatsbl. f. Augenh. **126**:451-460, 1955.

It is rare that a foreign body remains in the eye, causing a secondary glaucoma only many years after the original injury. Four such cases are described. It is assumed that a damage to the ciliary body causes the glaucoma. The prognosis is extremely poor. (1 table, 20 references)

Frederick C. Blodi.

Valière-Vialeix, and Robin, A. **Modifications of Lagrange's sclerecto-iridectomy. Incision ab externo.** Bull. et mém. Soc. franç. d'opht. **67**:484-507, 1954.

The difficulties in achieving a satisfactory fistulating scar in the surgery of chronic glaucoma are generally known. Success depends especially on the formation of a large conjunctival flap, together with the correct introduction of the knife into the anterior chamber and the exact cutting of a scleral edge. A modification of Lagrange's sclero-iridectomy is described; no claim for originality for this variation is made. This new technique, whose main variation is an incision ab externo by choice, is preferred to the trephining operation because of the more extensive opening of the chamber angle, the avoiding of the region of the ciliary body, the slight pressure on the eyeball during surgery, and reduced danger of late infection. (16 figures)

Alice R. Deutsch.

Weekers, L. **The scleral incision in iridencleisis.** Ann. d'ocul. **188**:163-172, Feb., 1955.

The main causes of iritis following filtering operations are: 1. operative trauma to the ciliary body, 2. delayed reformation of the anterior chamber, and 3. the use of miotics. In the author's technique of iridencleisis, trauma to the ciliary body is minimized by making an ab externo incision 1 mm. anterior to the root of the iris. The incision is perpendicular to the surface of the sclera and is completed suddenly so that the outflow of aqueous prolapses the iris, obviating the need for instrumentation within the globe. Because iridencleisis involves incision rather than excision of sclera, postoperative reformation of the anterior chamber

is more rapid than after Elliot trephining or Lagrange sclerectomy. The operation is contraindicated in any glaucomatous eye under the influence of D.F.P. Mydriatics, rather than miotics, should be used postoperatively. (3 figures)

John C. Locke.

10

CRYSTALLINE LENS

Alberth, B. **The extraction of the capsule after an extracapsular cataract operation.** Klin. Monatsbl. f. Augenh. **126**: 421-426, 1955.

If the capsule should break during the operation, removal of the entire capsule after the extraction of the lens should be attempted. The cornea is grasped with a forceps and lifted while the other hand extracts the capsule with the flat forceps of Blaskovicz. The cornea is only dropped after the capsule has been removed. Out of 696 accidentally extracapsular operations 650 could be made practically intracapsular by this method. Vitreous loss occurred in 36 cases. The striate keratopathy lasts for three to four days. No retinal detachment occurred. (18 references) Frederick C. Blodi.

Babel, J. **Cataract in idiopathic tetany.** Bull. et mém. Soc. franç. d'opht. **67**:328-337, 1954.

In this very interesting paper two main problems are discussed: 1. whether a differential diagnosis between endocrine and tetany cataract is possible, and 2. the relation between calcium metabolism and cataract.

The case history of a 50-year-old man is reported. He exhibited the signs and symptoms of pseudohypothyroidism, as described by Albright. He had a peculiar cataract in each eye with accentuation and partial opacification of the layers of lens fibers in the anterior cortex and a porous yellowish cup-shaped opacity in the posterior cortex. Both opacities were separated from the capsule by a clear band. The thickness of the lens was unchanged and no crystals or vacuoles were visible.

The cataracts which occur in association with the various forms of hypocalcemic tetany differ more in the speed of their development than morphologically. In postsurgical tetany the structure of the cataract is typical and the appearance and progression rapid when adequate treatment is not started in time. In chronic idiopathic tetany the appearance of the cataract is identical, but because of its slow development riders are visible which are not characteristic of the post-surgical variety. In pseudohypothyroidism (Albright) lens opacities are only rarely present. They appear late and change very little with and without treatment even in the presence of a very low calcemia. The disturbances in calcium metabolism undoubtedly are only contributary factors in the pathogenesis of tetany cataract, possibly preparing the way for the specific cataractogenous factor. (34 references, 3 figures) Alice R. Deutsch.

Calmettes, D., and Amalric. **Cataract extraction with Harrington's erisophake.** Bull. et mém. Soc. franç. d'opht. **67**:356-362, 1954.

Harrison's erisophake was used in 100 cataract operations, 75 of which were intracapsular. In several cases the erisophake lost its hold and the operation had to be finished by forceps extraction. The advantage of the erisophake is that it can be used in a taut capsule when the capsule forceps cannot get the right grasp; it also may help to form a fold of capsule for the subsequent use of the capsule forceps. The aspiration of Harrington's erisophake is less powerful than the Arruga model and one cannot extract the cataract with it alone. It easily skids on the lens surface.

Alice R. Deutsch.

NEWS ITEMS

Edited by Donald J. Lyle, M.D.
601 Union Trust Building, Cincinnati 2

News items should reach the editor by the 12th of the month but, to receive adequate publicity, notices of postgraduate courses, meetings, and so forth should be received at least three months before the date of occurrence.

Deaths

Dr. Edwin B. Miller, Philadelphia, Pennsylvania, died June 2, 1955, aged 83 years.

Dr. Richard H. Seely, Trenton, New Jersey, aged 34 years.

Announcements

Fellowship for eye research

The Massachusetts Lions Eye Research Fund has created the E. B. Dunphy Fellowship for Eye Research. This fellowship carries an annual stipend of $5,000 and will be awarded on a yearly basis by a committee consisting of Dr. David Cogan, Dr. Charles Schepens, Dr. William Stone, Jr., and Dr. Edwin B. Dunphy. Anyone may apply but the research must be conducted in Massachusetts.

Applications for 1956 must be received by November 1, 1955. Candidates should write to Dr. E. B. Dunphy, 243 Charles Street, Boston, Massachusetts, giving a short biography and two references. They should describe briefly the problem in which they are interested and state whether or not they have adequate laboratory facilities for doing the work.

Course on glaucoma

A course on glaucoma with particular emphasis on gonioscopy and the study of the anterior angle will be given at the Brooklyn Eye and Ear Hospital on November 14, 15, and 16, 1955. Ample opportunity for practical instruction in the use of the gonioprism will be given and material from the glaucoma clinic will be utilized.

The course will be conducted by Dr. Daniel Kravitz, assisted by Dr. Walter V. Moore, Dr. Mortimer A. Lasky, Dr. Harold F. Schilback, and Dr. Arthur Shainhouse.

Registration is limited to six ophthalmologists only.

Application and the fee of $40.00 may be addressed to Dr. Daniel Kravitz, Brooklyn Eye and Ear Hospital, 29 Greene Avenue, Brooklyn 38, New York.

Southern Research section

The Southern Section of the Association for Research in Ophthalmology will meet in Houston, Texas, on November 14th. On the program will be:

"Prevention of recurrent pterygium by prophylactic beta irradiation," Dr. Seymour B. Gostin, Veterans Administration Hospital, McKinney, Texas; "Tissue culture of the human eye," C. M. Pomerat, Ph.D., professor of cytology, director of the Tissue Culture Laboratory, University of Texas Medical School, Galveston.

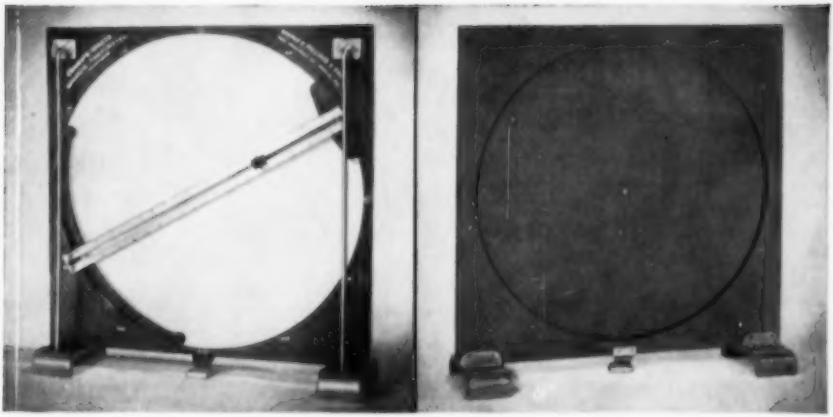
"The effect of chick embryo extract on growth of whole cornea explants," Robert A. Hoagland, M.S., Department of Ophthalmology, Tulane University, New Orleans; "Some properties of the water-soluble proteins of rabbit cornea," Marion A. Guidry, Ph.D., Department of Ophthalmology, Tulane University, New Orleans.

"A study of various types of eye injuries," Dr. K. W. Cosgrove, Dr. J. F. Henry, and Dr. Stevenson, Department of Ophthalmology, University of Arkansas, Little Rock; "Bacterial studies of keratitis," Mary L. Sigtenhorst and Wendell D. Gingrichi, Department of Ophthalmology, University of Texas Medical School, Galveston.

Schoenberg lecture

The Mark J. Schoenberg Memorial Lecture, sponsored jointly by the National Society for the Prevention of Blindness and the New York Society for Clinical Ophthalmology, will be given on Monday, December 5th at 8:15 P.M., at the New York Academy of Medicine. Dr. Irving H. Leopold, chairman of the Department of Ophthalmology of the Graduate School at the University of Pennsylvania, will speak on "Recent advances in the medical treatment of glaucoma."

This annual lecture is a memorial to the late Mark J. Schoenberg, M.D., who founded the New York Society for Clinical Ophthalmology and also was the first chairman of the National Society's Committee on Glaucoma. All physicians will be welcome.



*Conover-Spaeth**

MAGNETIC CAMPIMETER

***EDMUND B. SPAETH, M.D.**

PHILADELPHIA, PA.

This new precision instrument gives *accurate* determinations and correct configuration of the visual field with great savings of time and effort.

The Conover-Spaeth Campimeter is 24" square. It is placed on a table with the patient seated in front, his eye positioned 10½" from the central fixation point. The operator, standing behind the screen, facing the patient and looking directly into the patient's eye, is able to detect the slightest wavering. The test object is introduced to the visual field from a "Concealment Circle" and is controlled by a magnet from the back of the campimeter. The patient is not able to anticipate or even guess on which radius or from which side, right or left, the test object will appear.

This assures accuracy and eliminates time-consuming rechecking.

The back of the campimeter is clearly marked in degrees of the circle and angles of vision to conform to the standard Berens chart. Each radius tested is immediately entered on the chart . . . No markers to be placed or removed.

The time saved in each examination creates opportunities for more "fields" or other office work.

√ ABSOLUTE ACCURACY

√ FAR FASTER

Write for detailed information.

DISPENSING SERVICE

Main Office:
109 N. Wabash Ave., at Wash.
Chicago, Illinois

Austin Belgard INC.

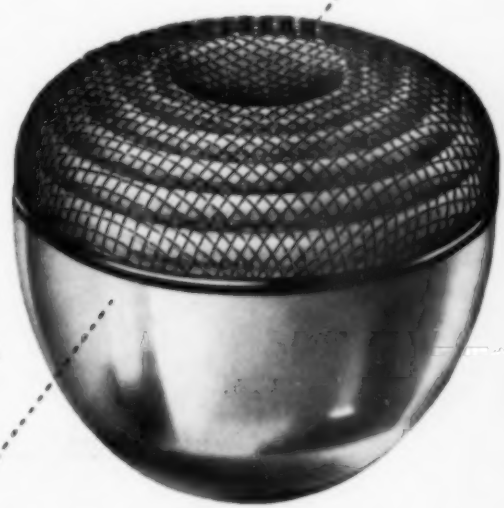
(formerly Belgard, Inc.)

OPHTHALMIC OPTICIANS
Wholesale & Service

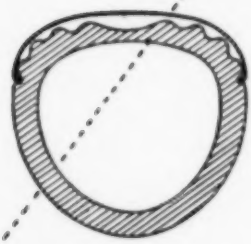
Branch Offices:
1920 W. Harrison St. at Ogden
1139 Central Ave., Wilmette, Ill.

AO MONOPLEX† MESHED CAPPED HOLLOW BURIED IMPLANT

by
G. BONACCOLTO, M.D.*



HOLLOW PLASTIC GREATLY REDUCES WEIGHT



Cross section showing hollow construction and stainless steel mesh.

Materials are inert stainless steel mesh (to which muscles are attached) over a hollow methyl methacrylate body.

SIZES:
Small (16.5 mm.); Medium (18.0 mm.); and Large (19.5 mm.). Available through your nearest American Optical Company office.

Operative procedure by Dr. Bonaccolto available by writing to: American Optical Co., Monoplex Department, Southbridge, Mass.

**This implant and operative procedure was first presented at the International Congress of Ophthalmology in New York in September, 1954.*

American Optical

†T.M. Reg. by American Optical Company